The Engineer.

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VOL. CLI.—No. 3931] LONDON: FRIDAY EVENING, MAY 15, 1931 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 2nd June, 1931, for LOW-PRESSURE HOT WATER HEATING, &c., at Bethnal Green (Bow) Telephone Exchange.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, and forms for Tender, may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 6975

For Sale.—Four Dis- MANTLED HYDRAULIC PRESSES for general purposes, with Intensifier. Designed for a pressure of 700 lb. per square inch, or an intensified pressure of 3360 lb. per square inch, complete with interconnecting pipes and operating valves.

Size of press tables	2ft. by 2ft.
Clear height for goods	4ft. 6in.
Diam. of press ram	6in.
Stroke of ditto	3ft.

Constructed by the Hydraulic Eng. Co., Ltd., Chester, about 1899.

All in good serviceable condition.

May be seen at the INDIA STORE DEPARTMENT, Belvedere-road, Lambeth, London, S.E. 1, between 10 a.m. and 5 p.m. (Saturday, 1 p.m.). 6920

Technical Assistants. THREE MECHANICAL ENGINEERS (unpensionable). Salary £175 to £275 per annum, according to qualifications, plus variable bonus (present total about £246 to £367). Must be British subjects. Age not exceeding 27 years. Preference and age concession to ex-Service men. Degree, or equivalent examination certificates, and suitable workshop training essential.

Application forms, returnable by 25th May, 1931, from CHIEF SUPERINTENDENT of ORDNANCE FACTORIES, Royal Arsenal, Woolwich, S.E. 18. 6976

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IN THE CITY OF LONDON.

LECTURES IN METALLURGY.

The Company have arranged for COURSES of THREE LECTURES to be delivered as follows:—

At the Royal School of Mines, Prince Consort-road, South Kensington, at 8 p.m. on Thursdays, 21st and 28th May, and 4th June, 1931, by
ULICK R. EVANS, Esq., M.A., on
"THIN FILMS ON METALS."

At King's College, Strand, W.C. 2, at 5.30 p.m. on Wednesdays, 27th May, and 3rd and 10th June, 1931, by
Dr. WALTER ROSENHAIN, F. Inst. Met.,
F. Inst. P., F.R.S., on
"SOME IMPURITIES IN METALS AND THE PRODUCTION OF METALS OF HIGH PURITY."

Admission free, without ticket. 6960

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER).

APPOINTMENT OF DIRECTOR OF THE DEPARTMENT OF INDUSTRIAL ADMINISTRATION.

The Governing Body invites APPLICATIONS for the POST of DIRECTOR of the DEPARTMENT of INDUSTRIAL ADMINISTRATION in the College, with the title and status of Lecturer in Industrial Administration in the University of Manchester.

Salary £700 per annum.

Conditions of appointment and form of application, which must be returned on or before 22nd June next, may be obtained on application to the Registrar, College of Technology, Manchester.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

B. MOUAT JONES,
6968 Principal of the College.

University of Bristol.

FACULTY OF ENGINEERING.

The UNIVERSITY invites APPLICATIONS for the following POSTS:—

A LECTURESHIP in METALLURGY (Grade II.). Salary £400 to £500, according to qualifications.

An ASSISTANT LECTURESHIP in CIVIL ENGINEERING (Grade III.). Salary £300.

An ASSISTANT LECTURESHIP in ELECTRICAL ENGINEERING (Grade III.). Salary £300.

An ASSISTANT LECTURESHIP in MATHEMATICS (Grade III.). Salary £300.

Applications should reach the undersigned, from whom further particulars may be obtained, on or before Tuesday, June 9th, 1931.

WINIFRED SHAPLAND,
6940 Secretary and Acting Registrar.

The Manchester Steam Users' ASSOCIATION.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, 20, QUAY-STREET, DEANSGATE, MANCHESTER. Founded 1854 by SIR WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers Inspected during construction. 6605

Trinity House, London.

TO BUILDERS AND CONTRACTORS.

The Corporation of Trinity House invite TENDERS for CARRYING OUT certain PAVING WORKS and RELAYING on a PILED FOUNDATION the 8-TON CRANE ROAD at Trinity Wharf, Blackwall, London, E. 14.

Forms of Tender, specification and drawings can be obtained upon the payment of a deposit of £1 (to be refunded on receipt of a bona fide Tender and the return of all the drawings and documents furnished), on application to the Secretary, Trinity House, Tower Hill, London, E.C. 3, to whom the Tenders are to be sent not later than 10 a.m. on Thursday, 4th June, 1931, in sealed envelopes, marked outside "Tender for Crane Road at Blackwall Wharf."

The Corporation of Trinity House do not bind themselves to accept the lowest or any Tender.

M. K. SMITH,
6969 Secretary.

The Engineer

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PUBLIC NOTICES

Bikaner State Railway. FOUR LOCOMOTIVE ENGINES AND TENDERS, STANDARD 4-6-2 "YB" TYPE.

TENDERS are INVITED for the above. Specifications and Tender forms may be obtained from the Consulting Engineers, Messrs. RENDEL, PALMER and TRITTON, 55, Broadway, Westminster, London, S.W. 1 (on payment of the fee of £1, which will not be returned), to whom Tenders are returnable by Twelve o'clock Noon on June 4th, 1931. 6972

Egyptian Government. APPOINTMENT OF FOUR LOCOMOTIVE INSPECTORS.

APPLICATIONS are INVITED for the APPOINTMENT of FOUR LOCOMOTIVE INSPECTORS in the Mechanical Department of the Egyptian State Railways, Telegraphs and Telephones Administration.

Applicants must be of British nationality, about 30 years of age and possess the following qualifications:—

I. Must have had a fair general education.
II. Must have had a good regular training as enginemen in cleaning, firing and driving, and should have had a certain experience with running repair gangs in sheds.
III. Must be well versed in the rules of locomotive running.
IV. Must be competent to detect defects, able clearly to report upon same and to remedy minor defects on the road.
V. Must be of exceptionally good character, steady and reliable, and show ability to control men in lower grades.

It should be clearly understood that those appointed may be required to serve a period of twelve months' probation on the footplate as drivers. This will give them an opportunity of coming into personal contact with the men they will be called upon to control.

Salary £E360 per annum (£E1 equals £1 0s. 6d. approximately), free of Egyptian income tax.

The appointment is subject to medical examination and approval of the authorities in Egypt.

The selected candidate will be granted a transfer allowance equal to one month's salary for change of residence from England to Egypt and vice versa.

Period of contract 3 years.

Third-class fares and reasonable out-of-pocket expenses will be paid to applicants who are requested to attend for interview and/or medical examination.

Application and specimen contract forms may be obtained from
THE CHIEF INSPECTING ENGINEER,
Egyptian Government,
41, Tothill-street, London, S.W. 1,
to whom they should be returned, with full particulars as to education, qualifications, previous experience, personal references, and COPIES of certificates or testimonials.

Envelopes to be inscribed "Locomotive Inspector." 6963

PUBLIC NOTICES

Metropolitan Water Board. DISPOSAL OF OBSOLETE PUMPING PLANT AS SCRAP MATERIAL.

The Metropolitan Water Board invite TENDERS for the DISMANTLING PURCHASE as SCRAP and REMOVAL of TWO OBSOLETE STEAM ENGINES at their Woodford Pumping Station, Forest-road, Walthamstow, E. The plant comprises approximately 23 tons of cast iron in addition to small amounts of steel and brass.

The plant may be inspected at the above-mentioned works between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon) on application to the foreman-in-charge.

Forms of Tender, containing particulars of the plant and conditions of sale, may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 155) or upon forwarding a stamped addressed sack envelope.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Scrap Material," must be delivered to the offices of the Board (Room 122) not later than 11 a.m. on Tuesday, 2nd June, 1931.

The Board do not bind themselves to accept the highest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
11th May, 1931. 6959

The Tralee and Fenit Pier and Harbour Commissioners invite TENDERS for the SUPPLY and ERECTION of a LOCOMOTIVE STEAM CRANE at Fenit in accordance with specification, copy of which can be had on application to the undersigned.

Sealed Tenders to reach me not later than Monday, 16th inst.

The lowest or any Tender not necessarily accepted.

J. LAWLOR,
Harbour Offices, Tralee, Secretary.
May 4th, 1931. 6948

County Council of Middlesex. WANTED, an ASSISTANT RESIDENT ENGINEER, with special experience in Supervising and Measuring Up of Reinforced Concrete and Stonework. Salary £400 per annum. Length of engagement approximately 2 years. Applications, stating age, experience, and other details, to be sent to the undersigned not later than first post on Monday, 1st June.

A. DRYLAND, M. Inst. C.E.,
County Engineer and Surveyor.
Middlesex Guildhall,
Westminster, S.W. 1. 6961

SITUATIONS OPEN

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Applications, which should give age and fullest particulars of previous positions held and salary required, will be treated in strict confidence.

Also state if at present in employment.

Address, 6954, The Engineer Office. 6954 A

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60 H.P. Modern Petter CRUDE OIL ENGINE.
36 H.P. Ruston HORIZONTAL CRUDE OIL ENGINE.
120 and 45-kW Allen STEAM GENERATING SETS, 230 vo. D.C.
20 N.H.P. Robey COLONIAL BOILER, 120 lb. w.p.
Weir BOILER FEED PUMPS from 1600 to 15,000 g.p.h.
VERTICAL THREE-THROW CARGO RAM PUMP, by Fearn, 11in. rams, 12in. stroke, 400 volts D.C.
HARRY H. GARDAM and CO., Limited, Staines. 6934 G

For continuation of For Sale Advertisements see page 70.

Spencer-Bonecourt Patent Waste Heat Boilers.
Broadway Bldgs., Broadway, Westminster, S.W. 1.

The Metallurgist
"The Metallurgist" is a free supplement accompanying the last issue of "The Engineer" for each month.
It is devoted entirely to the science and practice of Metallurgy—ferrous and non-ferrous.
The following comments by a few of our readers indicate its usefulness in a field hitherto much neglected.
"The supplement is very well arranged and will be of considerable value to the Metallurgical Industry."—Sheffield, February, 1925.
"The advantages gained by the metallurgist and the engineer through closer contact is obvious and your supplement should aid in this...."—Washington, U.S.A., February, 1925.
"... Metallurgical Supplement is undoubtedly very good."—Manchester, January, 1926.
"The Metallurgist is indeed a very splendid paper."
"... the high standard of these supplements which falls into a No Man's Land Land between research workers and users...."—Birmingham, January, 1927.
"... supplements which are of a high order and very interesting."—Newcastle, January, 1927

A Seven-Day Journal

Fuels for Motor Vehicles.

A COMMITTEE of the Society of Motor Manufacturers and Traders, Ltd., discussed recently the desirability or otherwise of establishing standard fuel specifications for motor vehicles, but it was agreed that the conditions precluded such a possibility, and that such standards might be a source of embarrassment. With a view, however, to assisting commercial vehicle manufacturers and others, the Committee prepared four memoranda. In the first two it is pointed out that though the commercial vehicle may not possess the social status of the private car, its functions and materials are similar, and therefore the use of low-grade fuels, many of which are found to be adulterated with paraffin, is false economy. The action of a fuel which is not properly vaporised is to wash away the protective film of lubricant on the cylinder walls and increase wear and tear, besides which serious effects follow upon the consequent dilution of the crank case oil. The third and fourth memoranda deal with the subject of fuels for commercial vehicles driven by oil engines. It is pointed out that the main attraction of such vehicles lies in the hope of a greatly diminished fuel bill. To obtain a true perspective of the position, however, the sources from which the fuel is obtained must be observed. The basic fact is that a barrel of crude oil costs a definite sum, and must, after treatment, produce a definite return, irrespective of the form of the final products. Thus the law of supply and demand will increase the price of Diesel oil if the consumption of petrol decreases. At the same time it is unreasonable to suppose that if such oil came into general use it would long remain untaxed. There seems to be little likelihood, therefore, of much economy from the use of such oils.

Sir A. C. Houston and the M.W.B.

THE Metropolitan Water Board has adopted a resolution that the services of Sir Alexander C. Houston, the Board's Director of Water Examination, shall be still further retained until September, 1932, notwithstanding the fact that he has passed the age for retiring. In its report recommending this step, the Water Examination Committee stated that in its view the Board would be impoverished by the loss of such an eminent scientist, and that it was unanimously of opinion that the Director should be retained for some years, subject, of course, to his health remaining unimpaired. The Committee went on to state that Sir Alexander was thirty-nine years of age when he entered the service of the Board in 1905, and that he had then attained a position of considerable eminence in his profession, being at that time Bacteriologist to the Royal Commission on Sewage Disposal. It pointed out, too, that since his appointment, he had been frequently employed by Government Departments and public bodies, including the late Local Government Board and the London County Council, to carry out investigations bearing on questions of water supply and allied problems. All who have known Sir Alexander and the excellent services which he has rendered by his investigations into the complex difficulties surrounding water supply matters—not only to the Board, but to the community at large—will unite in wishing that he may long enjoy such health as will enable him to continue to be retained in his office. Apart from other considerations, the cessation of his delightful annual Reports would, of itself, be a calamity!

Position of the Shipbuilding Industry.

A STATEMENT by Mr. A. L. Ayre, President of the Shipbuilding Employers' Federation, made at the preliminary conference with the shipyard trade unions in London on April 24th, has now been issued in booklet form. It shows very clearly the serious position of the shipbuilding industry. At the beginning of 1930 orders were coming in at the rate of 1,500,000 tons a year, which was sufficient to balance the amount of work going through the yards. In March of that year 1,615,000 tons were under construction, but that figure shrunk successively to 1,117,000 tons in September, 1930, to 909,000 tons in December, 1930, and to only 694,000 tons in March last; the number of ships corresponding to these figures shrinking from 362 to 132. Two ships, the new Cunarder and the "Empress of Britain," accounted for 110,000 tons of the tonnage under construction in March. For the four quarters of 1930 the tonnage launched was twice the tonnage laid down, but the latter amounted to only 32,685. The year's orders to March, 1931, namely, 326,000 tons, may be contrasted with a building capacity of 3,000,000 tons per annum. Twenty-five yards were entirely closed and others will be shut down when work in hand is completed. The figures for the ship-repairing side of the industry show an equally serious decline. Comparing the shipbuilding position of Great Britain with that of the world, the output of British tonnage in the year ending March, 1931, fell by 921,000 tons, while that of other countries fell only by 345,000 tons. Great Britain is now building no more than one-third of the world tonnage, and commencing much less, and Denmark, France, and the United States each began more new tonnage in the last quarter than Great Britain. Suggestions are included for bringing about an improvement. It is pointed out that the wages of some grades of piece-workers are excessive; that high taxation seriously handicaps the industry; and that the increasing number of Government regulations and restrictions is a matter for grave concern. Finally, a plea is made for greater assistance and co-operation on the part of the unions, similar to that received many times in the past.

Calcutta Electricity.

AT the thirty-fourth annual general meeting of the Calcutta Electric Supply Corporation, Ltd., held on May 11th, at the Waldorf Hotel, the chairman, the Right Hon. Lord Meston of Agra and Dunottar, stated that, in spite of political excitement, boycotts and severe trade depression, the business of the Corporation had not been bad. There had been a gratifying increase in the number of consumers, both industrial and domestic, but, owing to the depression in the jute industry, the gross revenue was only £27,000, and the effect on the load factor had caused a rise of £16,000 in running costs. The system of distributing surplus profits between shareholders and consumers, which began two years ago, had not met with the popular success hoped for, and in place of the consumers' bonds, the Board had decided to reduce the domestic flat rate from 3 annas to 2¾ annas, a concession worth over £50,000 a year to the consumers. The chief engineering developments of the year included work on the tunnel under the river Hooghly. Both shafts had been sunk and the tunnel was more than half-way on its course. At the northern end of the Corporation's system, a new ring main had been energised at 20,000 volts up one side of the river, as far as Serampore, and a licence had been secured for the important railway centre of Lilloosh, north of Howrah. Improvements had been made in the Corporation's power stations. At Cossipore two new boilers, each capable of evaporating 50,000 lb. per hour, were put into commission last July, and the work of remodelling the older part of the power-house was steadily advancing. At the southern station a 20,000-kW turbo-alternator had been erected.

The V.D.I.

ON Tuesday last, May 12th, a memorial statue, commemorating the seventy-fifth anniversary of the Verein deutscher Ingenieure, was unveiled at Alexisbad, in the Hartz Mountains, where, in 1856, a group of twenty-three young German engineers came together to found an association the object of which was to co-ordinate the efforts of the best technical brains for the benefit of the whole industry of the country. To-day, the Verein deutscher Ingenieure has over 31,000 members. In Germany there are now fifty-three distinct sections, and twenty-nine local branches of the Association, in addition to three branches abroad—in the Argentine, in China and in Japan. The literary activities of the Association early found expression in the *Zeitschrift des Vereines deutscher Ingenieure*, which has now developed into a technical journal of world-wide reputation. Associated with the V.D.I. Journal are many other technical periodicals, which deal with specialised branches of engineering and technical science. The V.D.I. has undertaken, by means of its various committees, wide fields of investigation, research work and standardisation, and its organising ability was recently strikingly illustrated by the excellent arrangements which were made last year for the World Power Conference in Berlin. In addition to the unveiling ceremony, which took place at Alexisbad on Tuesday last, the forthcoming annual summer meeting of the V.D.I., to be held at Cologne, from June 27th to June 29th, will take the form of a jubilee celebration. It is expected that a large number of scientific societies and engineering institutions abroad will participate in the Cologne jubilee meeting and will send special delegates.

The Bergen-Newcastle Motor Ship Venus.

ON Saturday of last week the B. and N. Royal Mail Line invited a party of British guests to make the round voyage from Newcastle on the new Newcastle–Bergen motor vessel "Venus." This new ship is scheduled to leave Newcastle on Tuesdays and Saturdays, returning from Bergen on Mondays and Saturdays, the quay to quay voyage being made in 20½ hours. She is of the flush-deck type, with a big sheer and double breakwater, which keeps her dry, even in heavy winter weather. Her length is 395ft. between perpendiculars, with a breadth moulded of 54ft. and a depth to the awning deck of 32ft. Her displacement is 7000 tons, with a loaded draught of 20ft. The passenger accommodation is distributed over four decks and over eighty-four single-berth cabins have been provided. With her two funnels and superstructure, she is in appearance a miniature Atlantic liner. The propelling machinery comprises two Burmeister and Wain airless-injection trunk-piston motors operating on the four-stroke principle, with continuous supercharging. Each engine has ten cylinders, each with a bore of 24·8in. diameter, and a stroke of 47·24in. The maximum output for each set of engines is 5125 S.H.P., while the normal service output is about 4500 S.H.P. at 155 r.p.m. Besides the passenger accommodation there is a large cargo capacity, both for ordinary cargo and for refrigerated goods. A feature of the hull design is the very large amount of water ballast carried, which can be distributed either high or low in the ship, according to her loaded condition, thereby assuring easy movement in a seaway.

The British Science Guild.

AT the annual meeting of the British Science Guild, which was held at the offices of the Western Electric Company, at Bush House, last Tuesday, May 12th, Sir Samuel Hoare was re-elected as President. In a speech after his election, he said that as the annual report showed, the Guild was anxious to embark upon a more ambitious programme, and intended to undertake an investigation of the potentialities of existing industries and the effect that the proper application of science would have upon them. What inquiry, he asked, could be more useful at the present moment? British industry stood confronted with difficulties that were scarcely imagined before the war, competition had become keener, taxation heavier, and quantities of capital had been dissipated into space. A crisis such as those things meant needed all the help that scientific inquiry could apply. Were successive Governments helping or hindering the application of science to industry? How far were reactionary employers and equally reactionary trade unions impeding progress? Those were the kind of questions that the Guild had to deal with in its inquiry. He was certain that if it was given adequate support, it would be able to perform a really useful piece of work at a very critical time.

The Automobile Racing Association.

LAST Tuesday, May 12th, a luncheon was held at the Savoy Hotel to inaugurate the recently formed Automobile Racing Association. This Association has for its object the creation of a great speedway for racing purposes, the development of a track for world's speed record attempts, the making of a waterway for speed-boat events, and the provision of an aerodrome. A site has been found, which it is believed will be suitable for all these purposes, on the north side of the Wash. Here 15 miles of foreshore, it is claimed, can be converted at very small cost into one of the finest natural speedways in the world. The opinions of a number of famous car drivers and motor tire manufacturers were sought, and in every case the belief was expressed that the surface to be obtained at the site was especially suitable. Further inland on the reclaimed ground, a "T.T." course is to be constructed, 12 miles in length, and it is hoped that an aerodrome will also be included. The project requires the building of a long wall to keep out the sea. It is proposed that the pit from which the earth to make the wall is dug shall form the lake for the use of speed-boats. Large stands are to be constructed, and Mr. J. Emberton, A.R.I.B.A., has prepared a general lay-out. In February satisfactory terms on which the land could be acquired were announced by the Board of Trade with the concurrence of the Commissioners of Crown Lands and the Duchy of Lancaster, and it is hoped that it will be possible to start construction during the summer or the early autumn.

The London Transport Bill.

WHEN the Joint Committee which is considering the Government's London Passenger Transport Bill met on Tuesday last, May 12th, after a fortnight's adjournment, the announcement was made by Mr. Wilfrid Greene, K.C., that a settlement had been reached by the Minister of Transport with the four main line railway companies, in addition to the agreement with the Underground group, which withdrew their parties from the list of opponents of the measure. The settlement with the railway companies provides for the pooling of their passenger receipts in the London area with those of the various undertakings which are to be under the control of the Board which the Bill will set up. The pool of receipts will amount, it is expected, to £37,000,000 a year, and will introduce a further element of stability to the scheme. According to the 1929 figures, out of a total of 2954 million passengers carried in the London area by the company-owned undertakings, 89 per cent. were carried by the Underground group and the main line railway companies, which has now come to an agreement with the Minister of Transport. Those companies with which no agreement has yet been reached only represent 11 per cent. of the traffic. The advantages of the agreement were, said Mr. Wilfrid Greene, important in two main directions. First, the main line railways had, in the past, been hampered in their improvement and electrification schemes by unrestricted and uneconomical competition, which would, under the new scheme, be removed. Secondly, the unification brought about through the pooling of receipts would make possible improved facilities and through-bookings, with a better use of terminal stations and through-running, which, at the present time, was impossible, except in limited cases. The Minister of Transport was ready to enter into any further discussion with other parties who might really and fairly wish to come to an agreement with him in this matter.

Electrical Determination of Water Purity.

By G. F. TAGG, B.Sc., A.M.I.E.E.

Introduction.

For many industrial purposes and for steam-raising plant a plentiful supply of pure water is essential. A number of processes may be entirely ruined if there is any impurity, such as a trace of acid or alkali, present in the water, and for steam boilers it is essential that the feed water should be as free as possible from impurities, such as salt. Under modern conditions of high temperatures and pressures, a minute quantity of salt in the feed water may lead to serious damage to the boiler; and even under the best conditions impurities will collect in the boiler, necessitating blowing down at intervals. An impurity such as salt will cause the formation of scale in the boiler tubes, and if there is boiler priming may lead to erosion of the turbine blades. Although all due precautions are taken to ensure that the feed water is as pure as possible, it is necessary to carry out tests continuously to determine the amount of impurity present.

The attention of engineers and scientists has thus been directed for some considerable time to the problem of obtaining a simple and reliable means of continuously indicating the condition of the water. With the great advances which have been made in the science of electrical measurements, it has been found possible to develop electrical instruments which will give a continuous indication or graphic record of the amount of impurity present.

Electrical Conductivity of Water.

A number of instruments have been devised for this purpose, and they all measure fundamentally the electrical specific resistance or its reciprocal, the electrical conductivity of the water. Absolutely pure water is a non-conductor, but it becomes a conductor of electricity when it contains impurities. It was discovered by Kohlrausch that the conductivity is a measure of the amount of the impurity. He established the law that for weak concentrations the electrical conductivity is practically proportional to the amount of impurity present. A curve obtained by him is given in Fig. 1, showing the variation in

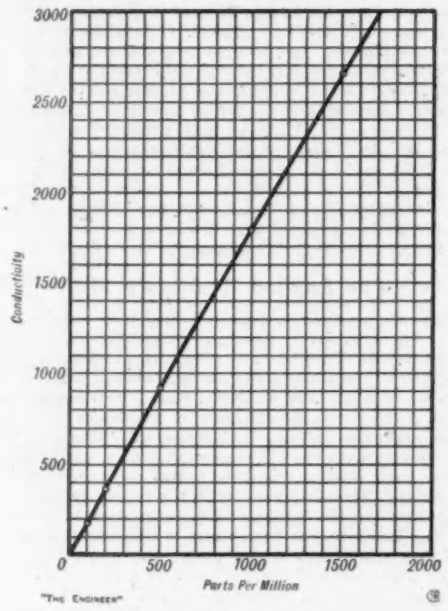


FIG. 1—CONDUCTIVITY OF SALT SOLUTION

conductivity of a dilute solution of sodium chloride with the amount of this salt present. The units in which the conductivity is expressed are reciprocal megohms per centimetre cube. The proportionality between the conductivity and the amount of sodium chloride is here shown very clearly. Thus the electrical conductivity affords a means of measuring the amount of impurity.

It should, however, be noted that although the electrical conductivity serves as a measure of the amount, it will not give any indication as to the nature of the impurity. In the majority of cases the nature of the impurity is well known, and it is only desired to keep a check on the quantity. For this, the electrical instruments are particularly suitable.

Unfortunately, the conductivity of a solution varies not only with the amount of impurity, but also with the temperature of the solution, increasing some 2·2 per cent. per degree Centigrade rise in temperature. Thus it is essential to take the temperature into account when measuring the conductivity or no comparison may exist between values obtained at different times when the temperatures are different. Several instruments have been devised which apply a correction for temperature variations, and give the equivalent conductivity at one fixed temperature.

Measurement of Conductivity.

Apparatus for the measurement of electrical resistance has been available for many years, and includes the voltmeter-ammeter, bridge, and ohmmeter methods, working on either A.C. or D.C. Most of these methods have been applied in one form or another to the measurement of the resistance of water. As mentioned earlier, pure water is practically a non-conductor, and water containing a very small quantity of impurity has a high resistance or low conductivity. In this country the water used for boiler feed is often very pure, and thus has a high resistance. This involves the use of very sensitive instruments to measure the resistance, and such instruments are usually operated by direct current. A.C. instruments are not generally so sensitive.

The use of D.C. for the measurement of an electrolytic resistance introduces difficulties owing to polarisation at the electrodes causing a back E.M.F. These difficulties can be overcome by using a low current density, and a high testing voltage, and very satisfactory instruments have been produced working on direct current. Many manufacturers have, however, developed instruments working on alternating current, usually on the bridge or ohmmeter principles, in order to overcome this difficulty, although polarisation is not entirely eliminated, even by the use of A.C.

Voltmeter-Ammeter Method.

One of the simplest methods of measuring resistance is to pass a current through it, and to measure the potential drop across it. The ratio of this potential drop to the current gives the value of the resistance.

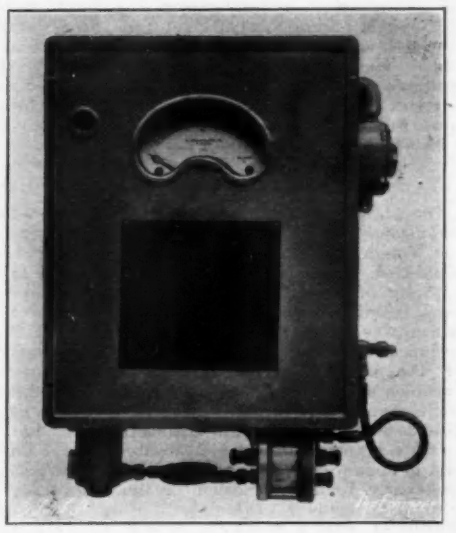


FIG. 2—CROCKATT SALINOMETER

An instrument working on this principle is made by W. Crockatt and Sons, Ltd., Glasgow, and an outside view is given in Fig. 2. A diagram illustrating the principle is given in Fig. 3. It will be seen that the indicating instrument is a milliammeter scaled in terms of the amount of the impurity present. The supply voltage is assumed to be constant, and thus the current through the milliammeter is proportional to the conductivity of the water. From the law of

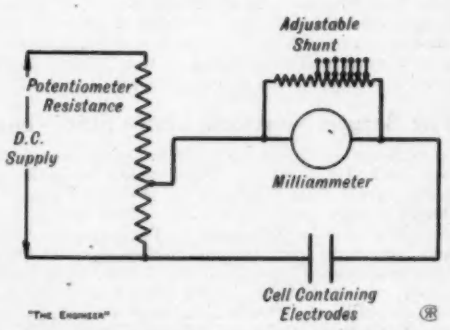


FIG. 3—DIAGRAM OF CROCKATT SALINOMETER

proportionality between the conductivity and the amount of impurity, as illustrated in Fig. 1, it is possible to scale the milliammeter in grains of chlorine per gallon. These instruments are intended for use with installations, such as those on board ship, where chlorides are the main impurities.

Temperature compensation is effected by means of a thermometer inserted in the water, this thermometer having platinum contacts fused through the glass in steps of 4 deg. Fah. These contacts are connected to tappings on a resistance which acts as a shunt across the milliammeter. The value of this shunt varies with the temperature, and the instrument readings are kept correct at one given temperature.

The indicator is normally scaled 0–0·5 grains of chlorine per gallon, and instruments can also be supplied having a range of 0–5 grains of chlorine per gallon. The normal range of temperature compensation is from 60 deg. to 120 deg. Fah., but it can be varied to suit particular circumstances. The water is led into and out of the cell containing the electrodes by insulating pipes, so that the presence of the electrodes in the water will not cause a dead earth on the supply used for operation.

It happens occasionally that there is a sudden increase in conductivity owing to an influx of impurity in the water, which may be caused by a sudden leak in the condenser. In this condition there would be a likelihood of damage to the milliammeter by overloading. To prevent this the instrument is fitted with a cut-out, so that if the impurity content rises to a value greater than the maximum scale reading, the indicating instrument is cut out of the circuit, and a lamp behind a red window lights up and thus gives a warning. When the water has regained its normal condition, the cut-out closes, the warning lamp is extinguished, and the instrument resumes its normal reading. If necessary, a Klaxon horn or warning bell can be added in addition to the lamp.

The chief advantages of this type of equipment are its sensitivity, its simplicity, the fact that it is protected against damage caused by a sudden increase in impurity and that a temperature compensation is fitted.

A.C. Bridge Method.

Some manufacturers have employed A.C. in their instruments, to reduce the effect of polarisation at the electrodes, thus allowing the electrodes to be

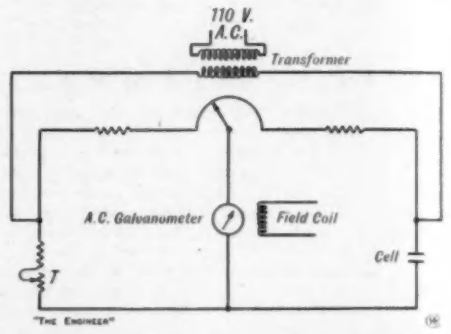


FIG. 4—DIAGRAM OF A.C. BRIDGE SALINOMETER

placed close together. In general, the A.C. instruments are of the bridge type, although there are also instruments working on the ohmmeter principle. An instrument working on the A.C. bridge principle is manufactured by the Leeds and Northrup Company, of Philadelphia, U.S.A., and a diagram of connections is shown in Fig. 4. This is a normal bridge arrangement and the function of the galvanometer is only

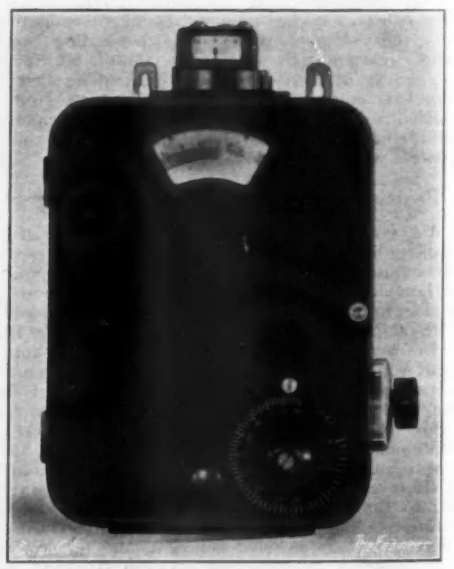


FIG. 5—LEEDS AND NORTHRUP SALINOMETER

to indicate balance, as is usual in bridge systems. As the galvanometer is only used for this purpose, it is possible to use a very sensitive instrument, and the currents through the arms of the bridge are very small, thus further reducing polarisation in the cell.

The cell containing the electrodes is included in one of the arms of the bridge, which is fed through a small transformer from an A.C. supply. The transformer also acts as an isolating transformer, so

that the insertion of the cell in the water does not cause an earth or leakage on the supply. Balance is obtained by adjusting a slide wire resistance, and the position of the contact on this slide wire is calibrated in terms either of the specific resistance of the water or of the amount of impurity present. An adjustment for temperature is provided in the form of an adjustable resistance in that arm of the bridge against which the cell is balanced. The temperature of the water is read off on a thermometer and the adjustable resistance is manually set to this value.

An outside view of a switchboard type of instrument is given in Fig. 5, in which the temperature adjustment can be seen in the bottom right-hand corner of the instrument. The galvanometer is on the top of the instrument, and the slide wire resistance is in the centre. The range is 0–10 grains of chlorine per gallon, and the temperature compensation is from 60 to 120 deg. Fah. The procedure is to determine the temperature of the water and set the temperature compensation to that value. The slide wire resistance is then adjusted until the galvanometer reads zero, and the amount of impurity is

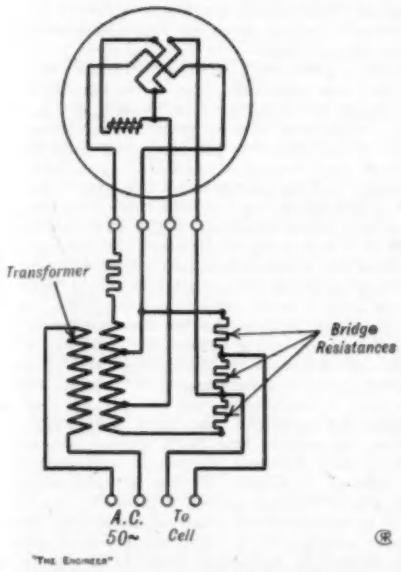


FIG. 6—DIAGRAM OF S. AND H. SALINOMETER

then read off on the scale. A recording type of instrument is also provided, if required, working on the self-balancing bridge principle, and the range is usually 0–10 grains of chlorine per gallon. The conductivity cells are constructed in two types, one for insertion in a pipe line, and the other for dipping in the water to be tested.

The advantages of this instrument are that it employs alternating current, and so overcomes polarisation difficulties, and that since it works on a bridge principle, it is unaffected by variations in the supply voltage.

Another form of apparatus which works on the A.C. bridge system is manufactured by Siemens and Halske, A.G., of Berlin. The principle of this instrument is illustrated in Fig. 6. The conductivity

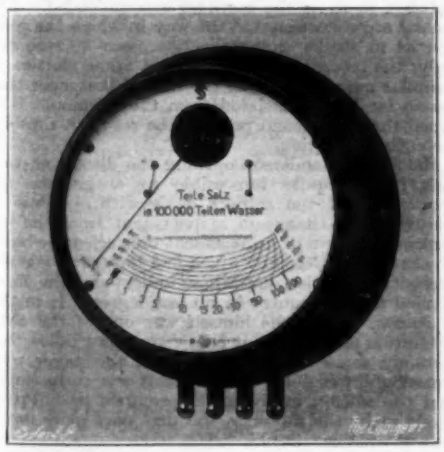


FIG. 7—SIEMENS AND HALSKE SALINOMETER

cell is included in one of the arms of a bridge, which is fed from an isolating transformer. In this instrument, however, the galvanometer acts as the indicating instrument, and the amount the bridge is out of balance serves as an indication of the resistance of the water in the cell. The field coil of the galvanometer is energised from the A.C. supply, and thus any indication of the resistance is made independent of variations of ±20 per cent. in the supply voltage. The instrument is scaled in Micro-Siemens per centimetre per square centimetre, which unit corresponds to a reciprocal megohm centimetre cube. It can also be scaled in terms of the quantity of salt present in the water, and in Fig. 7 is shown an illustration of such an indicating instrument.

Correction for temperature is made by using the multiple scale, seen in Fig. 7. The conductivity cells are of two types, one for continuous use, which is connected in a pipe line, and the second for portable use for dipping in the water. A thermometer is built into the fixed type of conductivity cell, and is easily accessible for reading. The indicator is provided with a mark on the scale beyond the zero conductivity point, to which the pointer deflects if the electrical and water connections are not in perfect order.

This instrument is not affected by normal variations in the supply voltage, but there is no continuous correction for temperature, and it is necessary to measure the temperature, and read off the conductivity on the correct temperature line on the scale.

OHMMETER METHOD.

The ohmmeter method has been used for a very long time for the commercial measurement of resistance, testing of insulation, and the like. It provides a sensitive means of measuring high resistances, and is thus particularly suitable for the measurement of the specific resistance of water. Ohmmeters may be constructed to work on either A.C. or D.C., the latter being the more sensitive, and both types have been applied to the present problem.

A.C. instruments working on the ohmmeter principle are manufactured by the Esterline-Angus Company, of Indianopolis, U.S.A. There are two distinct types of instrument, one of which is a condenser recorder, and the other a boiler concentration meter. The purpose of the former instrument is to make a record of the contamination of the condensate from a surface condenser owing either to leakage of the cooling water or priming of the boilers. The equipment consists of a recording instrument, and an electrode with holder.

The meter element in the recording instrument is of the dynamometer type, and has two pairs of fixed field coils. The moving system consists of two coils mounted at right angles to one another, and so arranged that the torques due to them are in opposition. The field coils are connected across the supply,

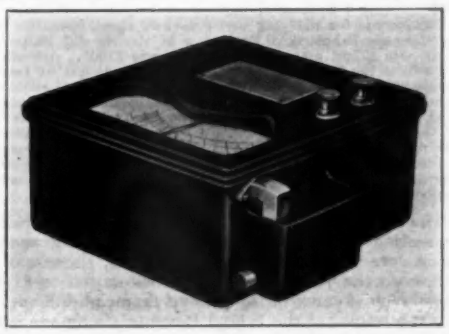


FIG. 8—CONCENTRATION METER

and the moving coils are connected, one in series with a fixed resistance, and the other with the conductivity cell, also across the supply. The instrument, therefore, operates as an ohmmeter having an A.C. field, and the final position of the moving system depends only on the resistance under test, and is independent of variations in the supply voltage.

A transformer contained in the multiplier case of the instrument is interposed between the supply and the moving system, so that the insertion of the electrodes in the water will not cause an earth on the supply system. The range of the recording instrument is 0–3000 ohms. There is, apparently, no means for correcting for variations in resistance owing to temperature changes. The electrodes are of special design, supported in a holder so that the electrode portion may be removed without affecting the flow of water.

The boiler concentration meter is illustrated in Fig. 8. A sample of the water to be tested is placed in the cup on the near side of the instrument. The salinometer is of the induction type and is shown diagrammatically in Fig. 9. There are two field coils C on a laminated iron core F. The disc of the induction movement is marked D, and on the opposite side of this disc to the field coils C is a sheet metal core with poles carrying coils A and B. These form two meter elements, and tend to move the disc in opposite directions. The coil A is connected to a fixed resistance contained in the instrument, and coil B is connected through E to the waters to be tested. Calibration is so effected that the position of the pointer is determined by the resistance of the water. The instrument is, in fact, an ohmmeter, and the indications are independent of variations in the supply voltage. It is operated from a 110-volt 60-cycle supply and is scaled from 1 to 10. These are purely arbitrary values and the purpose of the instrument is to regulate the process of blowing down the boiler. The operator has to determine what point on the scale represents such a value of concentration that the boiler must be blown down. To overcome the difficulty caused by the variation of the resistance with temperature the dial is provided with a series of scales for different temperatures.

Instruments of the ohmmeter type working on D.C. are the Dionic water purity meters manufactured by Evershed and Vignoles, Ltd., of London. The salinometer type consists of an indicator mounted on a water tube. This indicator is an ohmmeter, and the moving system consists of two coils mounted together at an angle and working in the field of a permanent magnet. One of these coils is connected across the D.C. supply in series with a fixed resistance, and the other is connected across the supply in series with the water under test. The torques of these two coils oppose one another and the indication is independent of variations in the supply voltage. The final position of the moving system, and thus the scale reading, depends only on the value of the resistance under

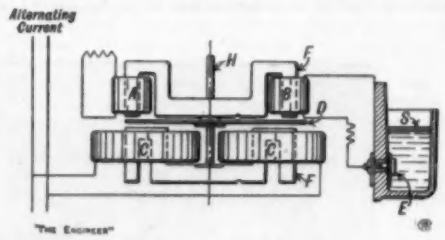


FIG. 9—ESTERLINE-ANGUS SALINOMETER

test, which is the resistance of a column of water in the water tube.

The arrangement of this tube is shown more clearly in the view in Fig. 10, which shows the apparatus with the front removed. The water flows through it continuously, and there are three fixed electrodes in the tube, the resistance of two columns of water in parallel being measured. Polarisation difficulties are overcome by using a long column of water and a relatively high testing voltage.

A continuous and automatic correction for temperature is obtained by varying the amount of water included in the measurement proportionately to the temperature. This is done by means of a bi-metal strip contained in the upper part of the water tube, which raises or lowers a plunger in the water, thereby altering the average cross section of the column of water under test. The normal range of temperature compensation is 10–80 deg. Cent. The range of the

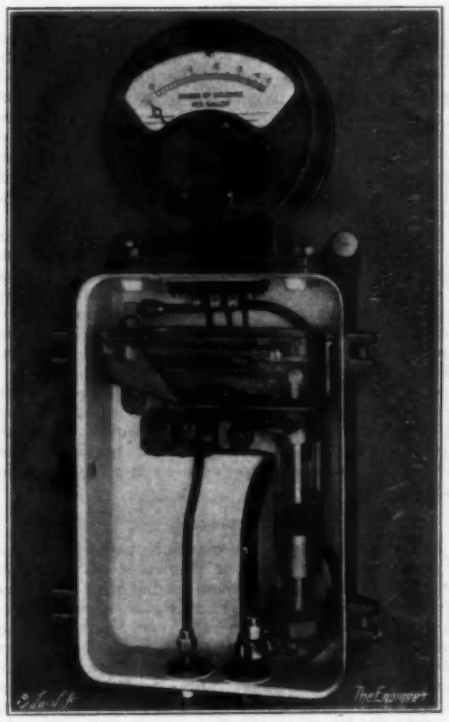


FIG. 10—EVERSHED AND VIGNOLES SALINOMETER

salinometer type of instrument is usually 0–0·5 grains of chlorine per gallon.

Water is led into and out of the tube by insulating pipes to prevent earthing the supply. The scale is logarithmic and the instrument will stand serious overload without damage. The indicator is provided with a "volts-off" position on the scale, so that in the event of the supply failing the pointer will drop back to this position and so give an indication as to what has occurred.

Equipments are also supplied in which the indicating instrument is separate from the water tube, and a recording instrument is often included. The recorder normally has two ranges, 0–10 and 0–100 units, the value of the unit being the reciprocal of 1 megohm per centimetre cube. Thus 10 units correspond to a specific resistance of 100,000 ohms

per centimetre cube. The indicator for these equipments has a single range of 0–100 units, and the scale is logarithmic in character, so that it may be read with equal accuracy at all points. This instrument may also be fitted with an alarm pointer, adjustable over the whole length of the scale, the alarm operating some warning device, such as a lamp or bell, when the conductivity reaches a predetermined value.

There are also instruments of this class of the portable type for testing samples of water. They consist of a water-tube unit of somewhat different construction from that of the continuously indicating type, and a conductivity meter. The latter contains, in addition to the ohmmeter, a D.C. generator as a source of supply. Correction for temperature is obtained by altering the length of the column of water under test by a manual operation. The equipment is illustrated in Fig. 11.

The advantages of the ohmmeter type of instrument are that it is independent of variations in the supply voltage. Furthermore, the D.C. type is very sensitive, and provides a continuous correction for temperature. The A.C. type is less sensitive, and the indicating pattern does not give a continuous indication of the condition of the water.

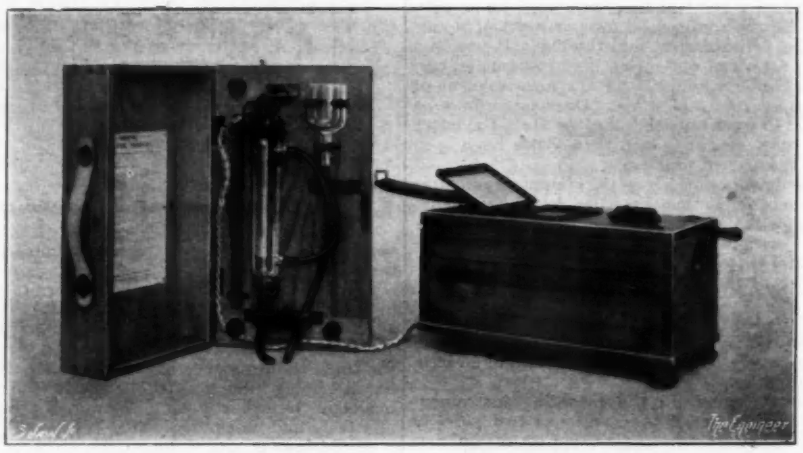


FIG. 11—EVERSHED AND VIGNOLES PORTABLE SALINOMETER

TESTING A NUMBER OF SUPPLIES.

It is often desired to test a number of different supplies, using only one equipment. This may be done in one of two ways. The first is to have a separate water-tube unit or conductivity cell for each of the supplies, and a selective arrangement whereby the indicating instrument can be connected to any of the water-tube units. This is done in the equipments supplied by Messrs. W. Crockatt and Sons, the Leeds and Northrup Company, and the Esterline Angus Company.

An alternative means is to use a mixing chamber, to which all the supplies are brought. The resulting mixture is then passed through the measuring portion of the instrument, and an indication is given of the average conductivity. If an unusual increase of conductivity is shown on the instrument, the supplies can be cut off, and tested individually to discover what is the cause of the increase.

This method cannot, however, be carried too far, as if a large number of supplies be tested in this way, an increase in conductivity of one supply may only produce a negligible increase in the conductivity of the whole. In general, any number up to five supplies can be so tested.

CONCLUSION.

It is essential that some means be provided to give a continuous indication of the state of the boiler feed water, particularly when dealing with high pressures and temperatures. Feed water, as used under modern conditions is generally very pure, and the amount of impurity is small. A number of instruments of various types for determining this impurity have been described above. It is essential to have an instrument which will give an accurate continuous record or indication of the amount of impurity, and it must give this in such a manner that values obtained at different times may be compared. This means that the values must always be given at the same temperature, and thus there must be a continuous correction for temperature. Lastly, the instruments must be robust and capable of operation over considerable periods without attention. These points have to be borne in mind when choosing an equipment.

In conclusion, the author's thanks are due to the manufacturers of the various instruments described for permission to incorporate descriptions and illustrations of their manufactures.

IT is announced that all the members of the American Aircraft Manufacturers' Association have decided in future to pool all plans and inventions as soon as they become ripe for patenting, so that they may be of mutual benefit.

The Iron and Steel Institute.

No. I.

THE Annual Meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, Great George-street, Westminster, London, on Thursday and Friday, May 7th and 8th.

On the opening day, May 7th, the retiring President, Professor Henry Louis, was in the chair, prior to the induction of the newly elected President, Colonel Sir Charles Wright. The first business was the presentation of the Annual Report of the Council which was adopted without discussion.

The report states that during the past year 116 new members and 11 associates were elected; 6 associates were transferred to membership, and 5 members were reinstated; 82 members resigned their membership during the year, and the names of 32 members were removed from the register owing to the non-payment of their subscriptions. The total membership of the Institute on the register on December 31st, 1930, was 2005, showing a decrease of 15.

The income for the year under review, apart from that of the Carnegie Scholarship Fund and of the Special Purposes Fund, was £7768, and the expenditure was £7907. Attention is drawn to the fact that, for the fifth time in the last six years, the accounts reveal a deficit, which, though not a great amount, is, nevertheless, of serious importance on account of the accumulated effect which is being produced on the Institute's reserves by the continual carrying forward of small adverse balances. The decline in income, which is due to a variety of causes, is principally attributable to increased taxation and to the present economic conditions which have led to a larger than usual number of resignations.

The Hon. Treasurer, Sir Harold Carpenter, F.R.S., presenting the accounts, expressed regret that again, as on several occasions in recent years, there was a deficit on the year's working. It amounted to £140, and the chief cause of the present financial difficulties was the refusal of the Inland Revenue Commissioners to allow the Institute's claim to refund of income tax on investments, the amount being about £420 per annum. An appeal for the recovery of that tax was pending.

The President then inducted his successor, Colonel Sir Charles Wright, into the chair, and the usual compliments were exchanged.

The first duty of the new President was the presentation of the Bessemer Gold Medal to Sir Harold Carpenter, F.R.S. In doing so, he said that the Institute was recognising, first, the great value of Sir Harold's many scientific researches; secondly, his unselfish efforts in the direction of creating a greater appreciation of the importance of the application of science to the industries of the country; and, thirdly, the wonderful influence he had had, as Professor of Metallurgy, in stimulating and encouraging an interest in the subject, and infusing a similar spirit of enthusiasm for research into the minds of many other workers. His researches had been concerned largely with the purely scientific side of metallurgy, but the results had been absorbed in almost every branch of the metallurgical industries, and, in that way, had had a marked influence upon their development. It was no exaggeration to say that a large proportion of Sir Harold's work had been so fundamental in character as to form the starting point and guiding principles of much of the research work which had been carried out by many other investigators. In 1906 he was appointed the first Professor of Metallurgy at the University of Manchester, and under his guidance that became a flourishing school, especially renowned for the researches which emanated from it. In 1914 he became Professor of Metallurgy at the Royal School of Mines (Imperial College of Science and Technology), London, and had unstintingly given his country the benefit of his wide knowledge, experience, and time by serving on many Government Committees of Inquiry and on the Advisory Council of the Department of Scientific and Industrial Research.

Sir Harold Carpenter said it was difficult to imagine a greater honour than that of being placed in a list that contained the names of some of the most illustrious metallurgists of the world. Speaking of his ancestor, Henry Cort, he said that Cort's discovery consisted of two parts, the puddling of cast iron on a reverberatory hearth and the rolling of that iron in grooved rolls. That process was nearly 150 years old, and was still alive to-day. It had, of course, been modified; a larger charge was worked on the hearth, the hearth itself was of different composition, and other alterations had been made, but the Cort process persisted in all its essentials after 150 years. If it were remembered that in that period it had been challenged by the great varieties of steel which now existed, it would be realised what a great invention it was. The output of wrought iron had, of course, dropped, and its death had often been predicted, but the funeral had never taken place, and he did not expect to see it. Wrought iron persisted because it was not like anything else; to use the puddlers' expression, it was a metal born in a bath of slag, and always contained slag, which constituted the essential and fundamental characteristic of wrought iron.

Speaking with regard to the future, Sir Harold expressed the view that the metallurgy of the future would have to come still closer than it had yet done to modern physics. In saying that he was thinking of two remarkable books which had recently been published. One was by Professor Joffre on "Physics of Crystals," which gave an interesting account of that worker's researches extending over a period of twenty-five years, and perhaps still more remarkable was the book published only a month ago by Mr. Hume-Rothery, entitled "The Metallic State," which pointed to the way in which we were already beginning to go. It was true that the book only dealt with the electronic conduction of electricity by metals, but ultimately all the properties of metals would have to be explained in terms of that theory, and the book gave a very clear indication of the way in which that theory was beginning to develop. In discussing this matter of the closer relationship between metallurgy and modern physics with various friends, it had seemed possible to take some action on these lines. A short while ago Sir William Larke and himself had the privilege of appearing before the Advisory Council of the Department of Scientific and Industrial Research, and recommending that body to encourage the study of metallurgy, particularly by physicists. In that, he included chemistry and engineering, because engineering was only applied physics, and the boundary between chemistry and physics was very difficult to define. He was pleased to say that the Advisory Council agreed with that view, and by way of encouraging the study of metallurgy from the physical standpoint, the Department had agreed to assist financially approved students in physics with a good record, who desired to follow a metallurgical career, and great and improved developments were likely to follow from that.

The President than delivered his Address, an abstract of which appeared in our columns last week, and on the motion of Sir Frederick Mills, a cordial vote of thanks was passed to him.

ECONOMICS IN STEEL WORKS.

The first paper, entitled "Production Economy in Iron and Steel Works," by Dr.-Ing. Otto Cromberg, of Düsseldorf, was presented in the author's absence by Mr. J. H. Turner, of the National Federation of Iron and Steel Manufacturers.

This is the first part of a complete paper dealing with the question of the best methods of organisation of steel and ironworks applying particularly to the German industry. Methods of time study are examined in close detail, and sheets of tables are included to show the methods recommended. The control of production and the way in which the position as to stocks and orders, &c., can be recorded daily, the recording of output, and other matters of a similar nature, make up the half of the paper that has so far been translated from the German. It is hoped that the second part will be ready in time for the autumn meeting.

Mr. James Henderson opening the discussion said that it was quite impossible to exaggerate the importance of the subject dealt with, because it related to the change of management from the old personal element to management on a scientific basis. The changes in Germany which had brought about the necessity for action on the lines indicated in the paper applied to this country in no less degree. It might, of course, be that he himself was one of the older generation and could not follow the newer ideas, but certainly some of the examples in the paper were almost unintelligible to him, and it was to be hoped that the author, in giving the promised second part, would make the tables in the first part more easily understandable.

Mr. W. Cunningham, commenting upon the statement by the author that there was nothing new in the principles he had laid down, mentioned a British foundry foreman's notebook dated 1850 in which there was a clear recognition, even at that time, that it was necessary to tie up wages systems with the time element. It was not until about 1880, however, that the first application of the stop watch to factory processes was made. That was carried out in America by F. W. Taylor, whose system was really the basis of Dr. Cromberg's paper, and it was rather interesting to find that what was in practice fifty years ago in America was now being brought to the notice of the Institute from Germany.

Professor C. H. Desch, speaking of the history of the subject, said that the introduction of time studies as a means of speeding up operations had always been attributed to F. W. Taylor in America, but it was not commonly known that something like a century ago in this country Charles Babbage, the inventor of the calculating machine, published a remarkable book entitled "The Economy of Arts and Manufactures," which contained a number of time and motion studies on individual operations on machines which were practically identical with the method adopted afterwards by Taylor. He did not think that Taylor was aware of that work and the book by Babbage had been commonly overlooked. Babbage was an erratic genius, but all his books were interesting, and that particular one threw a great deal of light on manufacturing processes at the time and was well worth reading even now.

Dr. J. C. Hudson asked that the paper should be carefully revised before publication, because it contained a large number of actual mathematical errors. In one case the efficiency of the worker was given as 110 per cent., which seemed to suggest that the efficiency of the observer must be very much less.

The next paper was by Mr. Arthur Robinson and described "The Melting Shop of the Appleby Iron Company, Ltd."

THE MELTING SHOP OF THE APPLEBY IRON COMPANY, LTD.

The subject of this paper is the melting shop of the Appleby Iron Company, Ltd., whose works are situated at Scunthorpe, Lincolnshire, and are owned and managed by the Frodingham Iron and Steel Company, Ltd.

Experience with both fixed and tilting furnaces at the Frodingham works has shown that the tilting furnace has considerable advantages, while for the production of large quantities of any quality of steel, the large furnace offers considerable advantages in economy of labour and upkeep.

A large mixer is necessary as a storage of molten iron. A small amount of refining is done, and any dirty scrap and off-grade iron can be melted.

The main building houses three 250-ton and one 300-ton tilting furnaces, and a 500-ton mixer placed centrally between them. The furnaces are charged by two 50-ton overhead cranes, with 15-ton auxiliary hoists and two 4-ton revolving ground-type chargers. A Blaw Knox fettling machine is used, and has proved extremely useful for fettling the back wall of these wide furnaces. The furnaces are heated normally by producer-gas.

The casting bay has three casting platforms which, together, extend the full length of the shop, with two rail connections through the side of the shop and one at each end. The shop is served by three overhead cranes, each capable of handling an 85-ton steel ladle. The steel is cast into ingot moulds set upon cars. The ingots are stripped in a separate building near the soaking pits. The 75-ton blast-furnace iron ladles are of the horizontal cylindrical mixer type, running on special bogies. The steel ladles hold 75 and 85 tons of steel, the slag pans 17 tons of slag, and the mixer transfer ladles 30 tons.

The covered stockway bay runs the full length of the charging platform, and is worked by two magnet cranes.

The gas-making plant includes nine producers with small overhead bunkers, fed by two grab cranes from a central storage of coal. The gas passes to a common overhead main, and thence by underground flues to the furnaces. Between the gas-producers and the stockyard are the chimney stacks, and water-tube boilers for the three 250-ton furnaces, with fans and superheaters and provision for firing with blast-furnace gas in case of need.

The manning of the shop, with four furnaces and mixer working to capacity, is 295 men in all—production, repair and maintenance men, crane men, labourers, managers, foremen, and office staff—equivalent to over 22 tons per man-week, including stoppages for repairs.

The gas-producers are 10ft. diameter brick-lined bodies with Kerpely revolving grates and ash ejection. They are fitted with Chapman automatic feeds and levellers and small Carling turbo-blowers. The ashes are ejected into buckets which travel along a light Morris overhead runway to an ash hoist. The coal used is principally 1in. by 1¼in. Yorkshire gas nuts with some Derby and Notts. coal.

The 500-ton mixer has a bath 48ft. by 19ft. by 6½ft. deep, is usually heated by blast-furnace gas, and uses 200,000ft. per hour, but provision is made for using producer-gas when necessary. An endeavour is made to supply iron of a regular composition rather than to do much refining.

A small amount of pig iron and scrap is melted, and about 6 per cent. of local basic ironstone, with about 20 per cent. of iron and 25 per cent. of lime, is used to make a slag which is kept in condition by the addition of a little limestone or scale as required. The slag—about 4½ per cent.—is sent to the blast-furnaces. A recording draught-gauge and gas-volume recorde are installed. The average CO_2 in the waste gases is 18 per cent.

The design of the three 250-ton furnaces is identical, and is based upon experience with the Frodingham tilting furnaces. The average run of the furnace is 18 to 20 weeks, or 36,000 tons, during which time it is not emptied under normal circumstances. At the end of a run repairs are made to the furnace top, and the slag holes and flues are cleaned.

Experience at the Frodingham works shows that thin basic bottoms last on the average about five years, when it is expedient to ram in a new bottom to prevent bottom troubles, and to make an opportunity for examining the underlying magnesite bricks.

Although, or because, the furnace bottom is very rarely seen during the run of the furnace, the wear varies from nil to 2in. New banks are rammed in at the slag line every run, and the wear on the bottom is replaced with dry burnt dolomite.

Several modifications were made on the 300-ton furnace, which is 2ft. wider than the 250-ton furnaces, has somewhat larger regenerators, and has Friedrich removable blocks with a longer gas port.

This furnace was started up in January, 1930, and up to date has run two campaigns. The first campaign made 47,226 tons, with a small repair at the end of 7500 tons, due to the collapse of the chill lining. After repairing the roof, blocks and linings, the second run made 43,397 tons, with no repairs except to a few door arches. The checkers are still in good condition. The experience gained shows that it will not be necessary under normal circumstances to change the block ports during a furnace run.

This larger furnace with a similar chimney has 2½in. of draught against a normal 1½in. at the others, the straight-through valves making a great improvement in this respect. It was found necessary to choke the draught to 1in.

All furnaces are fitted with fans for blowing the air required for combustion, and the 250-ton furnaces have exhaust fans at the waste heat boilers. There is no doubt that fan control of the air gives better control of combustion and a longer life to the furnace. Each furnace is fitted with Féry radiation pyrometers sighted on the end of a 3ft. tube above the air checkers. An air volume recorder on one furnace and recording draught gauges on the intake of the fans of the other furnaces give a further check on the handling of the furnaces. The constant recording of CO_2, &c., in the stack gases in the case of these furnaces does not appear to give any advantage.

The remainder of the paper describes the steel-making practice of the company, contains tables showing the typical working of three succeeding casts, and, finally, deals with casting practice.

Mr. F. Clements, opening the discussion, said the author's last comment, namely, that the paper described "modern steel works practice as carried out in Great Britain which will bear comparison with any modern practice elsewhere," had brought him up quite sharply, because in many quarters, certainly those which were not directly in touch with the steel industry in this country, the criticism always was that there was no such thing as modern practice in Great Britain. The industry had been told that to cure all its ills it had merely to introduce into this country huge plants of the continental or American type and thus repeat the conditions which existed in those other countries. That solution of our difficulties was not always sound. There were other things in steel production in these days than merely technical considerations. We in this country were favoured with a developed social democracy which had established a standard of living higher than elsewhere. That, of course, was not the occasion to discuss that matter, and he was merely stating it as a fact which had to be faced. As a result we knew that even if we produced in this country under the most favourable conditions, with plants of the most modern continental type, we were still under the handicap of higher wages, which no technical development could possibly eliminate. Therefore, it was necessary to look a little further ahead than the type of plant in use. The modern tendency was towards the adoption of definite and advanced types of steel to purposes for which hitherto only mild steel had been employed. Many of the difficulties with which the shipbuilding industry was faced would have to be solved by a definite step forward so that ships could be built of greater capacity for the same weight. That could not be done with mild steel, and we should have to develop something else. We had to face the fact that the demand for mild steel had shrunk, but there was a much wider field for steels of special character, many of which might even not yet have been developed. That, however, he regarded as the cream of the business for the steel industry. For it we should strive and leave the skimmed milk to the foreigner. It would be asked how all that was to be done. Frankly, he was merely thinking in the future, but, at the same time, a great deal had been done during the last ten years and the developments he had hinted at seemed to demand the mobilisation of all forces in order to control the position for the future. It was necessary to mobilise the whole of the technical side of the industry and the technical knowledge in our universities and technical colleges, where isolated researches were going on which, although admittedly of value, very often did not "get down to brass tacks." In the development of new materials for the future steel masters must organise the technology within their own works and develop the operating power of their factories; in fact, they must create within the steel industry a new outlook which would lift it to a higher level of production in every respect.

Mr. Benjamin Talbot said those who had had the opportunity of seeing the plant described in the paper, would have been convinced that Great Britain was not the inefficient country which it was often said to be by people who understood nothing about our iron and steel industry. Without any other knowledge, anyone reading the description of the plant of the Appleby Company, would have thought it to be a description of one of the best shops in America or Germany. About thirty years ago he read his first paper on the continuous process and visualised the 200-ton tilting furnace. Now there were 300-ton tilting furnaces, and he understood that Mr. Ford was designing, or probably had built, a 400-ton tilting furnace in America. At the Appleby works the operations started with a so-called mixer, but really it was not a mixer at all. It was a gas-fired preliminary furnace which did a certain amount of refining and must increase the temperature of the metal. It would be interesting to compare the difference in output from large furnaces—the metal coming straight from the blast-furnace—with the output of refined metal which came from the preliminary furnace at Scunthorpe. As regarded the design of the port of the 250-ton and of the 300-ton furnaces, there was a great difference in the angle of the air port on the latter. It seemed to be much steeper, if the diagrams were correct, than in the case of the 250-ton furnace. Probably early combustion was obtained by doing that.

Mr. W. Cunningham asked the author if he had endeavoured to control the furnace by oxygen content. It had been shown in a number of cases that a higher output and a lower fuel consumption were obtained when the oxygen in the gases varied between 2·5 and 4 per cent. With the higher percentage, the results were worse from both points of view.

The author, replying to the discussion, dealt first with the point raised by Mr. Clements that the future of the British steel trade lay in making better steels or special steels. Special steels, he said, were either steels of which only a very little was required or they were something better than were asked for by the ordinary buyer. With the tilting furnace, it was possible to start with a much more impure charge and to change the slag as many times as might be required. In that way one could get any required degree of purity much more easily than with a fixed furnace working on a dirty slag until the end. With an impure slag, it was possible to make the same quantity of steel in a tilting furnace as could be made with pure materials in a fixed furnace. The tilting furnace was very flexible, and any set of conditions could be duplicated on a much larger scale than in the case of the fixed furnace. The only reason for making special steels in small fixed furnaces was that the market for them was very limited, and as soon as it was an economic proposition to make them in large quantities, those steels would be made in large tilting furnaces quite as successfully and more cheaply than was now possible with the small fixed furnace. There were only two valid reasons for installing fixed furnaces in preference to tilting furnaces when large quantities of steel were required. The first was that scrap was plentiful and cheap and pig iron scarce and dear. In that case, shallow quick-melting furnaces of the continental type were required. The second reason for installing fixed furnaces in the circumstances mentioned was that scrap was not so plentiful, but pig iron was of such a composition that it had very low phosphorus, and perhaps very low impurities, so that there was very little slag to be carried in the furnace, but in the case of any charge which required a large amount of purification and carried heavy slag, the tilting furnace could make a better job.

Continuing, Mr. Robinson said he regretted that Mr. Talbot's name was not specifically mentioned in the paper, but he regarded Mr. Talbot as such an integral part of the industry as not to need special mention. With regard to the use of direct metal in these big furnaces, there was little doubt that if it were possible to obtain money necessary to do things as really desired, it would be possible to make iron without the mixer just as well as with it. He did not think there would be very much difference in the output in the two cases. The report by Herr Albert, to which he had referred, was an almost complete answer to what Mr. Clements had said about slag. As to the citric solubility of slag, the money obtained for the slag in normal times was quite a big item, and it paid to slow the furnace a little in order to obtain high citric solubility. There was no doubt that if steel makers did not care about the slag they could work slightly quicker, but on the whole it was felt that a cheaper steel was made by the method adopted. The basic slag contained about 6 per cent. of manganese; the iron from the mixer had slightly over 1 per cent. manganese, and it was found that if the steel was tapped with less than about 0·2 per cent. manganese, the steel was not so good. The air port in the 250-ton furnace was exactly the same as in the 300-ton furnace, the drawing not showing the thing exactly as it really was. Replying to the point by Mr. Cunningham as to the control of the furnace by means of the oxygen in the gases, it seemed to him that that would be open to similar objections to those found with the CO_2 recorder. At every reversal a certain amount of air was drawn into the system at the valves, or gas was drawn in at the gas valves, and the whole thing was upset for some minutes afterwards. Another factor with the big tilting furnace was the large reactions which took place when limestone was put in. In that case CO_2 was given off and again tended to upset records.

CORROSION.

The greater part of the afternoon of May 7th was devoted to the consideration of the report of a Joint Committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers to the Iron and Steel Industrial Research Council, this being the "Corrosion of Iron and Steel," an abstract of which is concluded on page 550 of this issue.

Dr. W. H. Hatfield, as chairman of the Joint Committee, briefly introduced the Report and said it contained a summary of work which had extended over a period of three years. He acknowledged the very substantial help that had been given to the Committee by steel makers, large users, such as railway companies, shipowners, &c., and also by the various Government Departments. The questionnaire that was issued was received in the most broad-minded manner by all to whom it was sent, and it was the first time that the maker and the user had collaborated with a view to putting on record up-to-date experience with regard to resistance to corrosion under the adverse conditions of ordinary mild steels of commerce. The most important information which it was hoped to obtain from the field experiments was a real index of the resistance to corrosion, under adverse conditions, of ordinary mild steel, having regard to the nature of the surface of the steel presented to the corroding media—whether it had the scale on or was painted, pickled or machined—and also varying weather conditions. With that object in view, corrosion stations had been established at many places on the earth's surface with the collaboration of the Government Departments and others.

Mr. U. R. Evans, as chairman of the Laboratory Corrosion Tests Sub-committee of the Joint Committee, then introduced Section E of the Report,

which deals with that side of the investigation, the object being to ascertain whether it was possible to find a laboratory test which would indicate the behaviour of different materials under service conditions. The tests which were dealt with in the Report, he said, were not really pronounced acceleration tests, because, although the results were obtained in a few weeks, the corrosion in that time had proceeded only as far as it was desired it should. It was unnecessary to produce a laboratory test which, in the course of a few weeks, would bring corrosion to a very advanced stage. For commercial purposes it was the time needed for the material to get into the early stages of corrosion which really mattered. Most steel was painted and it was necessary to know how soon it should be re-painted before corrosion reached an advanced stage, otherwise the new paint would simply come off again. Therefore, it was felt that for commercial purposes a laboratory test which indicated quickly the initial stages of corrosion was of the most practical use.

Dr. J. C. Hudson, the official investigator to the Joint Committee, followed with a brief general account of the procedure adopted in the field tests that have been made, and said they had not been in progress sufficiently long to enable any definite conclusions to be drawn from them. So far as could be seen at present, however, it was evident that the character of the scale might materially affect the process of corrosion in the early stages, and he anticipated that that fact would prove of great importance in the case of specimens that were exposed in the painted condition. He rather anticipated that the paint would adhere better to the red type of scale than to the black type, although, at the moment, that was mere conjecture. The Committee, however, had arranged for a second series of tests on the corrosion of wrought iron, in which attempts would be made to determine whether the actual process of manufacture had any effect upon materials of nominally the same composition. That second series of tests would be conducted on the same general lines as the first series now in progress.

Sir William Larke expressed the view that the work of the Joint Committee was likely ultimately to mark an epoch in iron and steel production. When the suggestion was first made to the Advisory Council of the Department of Scientific and Industrial Research that it was desirable to undertake an investigation into the corrosion of ferrous metals, he expressed a desire to discuss the matter with the industry and the Institute, rather than that the work should be entirely under official auspices. That suggestion was welcomed and the result was the appointment of the Joint Committee. The great feature of the Committee was that it represented practically the whole of the interests concerned.

Mr. T. M. Service said that during the past five or six years there had been an epidemic of local corrosion in ships built all over the British Isles, whether the steel used was British or foreign, acid or basic. He had recently been consulted in a case of that kind, and on going into the matter had found that nothing could be said against the steel, although usually it was blamed. The shipowner had stipulated for a red oxide paint to be used, but chemical analysis of the paint showed it to consist of 20 per cent. Fe_2O_3 and 70 per cent. of barium sulphate. Paint manufacturers whom he had consulted had told him that barium sulphate lacked covering power. In other words, to get the same covering power as with a genuine red oxide paint it was necessary to put on three or four coats of such a paint as he had mentioned, and with only one coat of that paint it was apparent that for all practical purposes the ship had not been painted at all. The steel used in the particular ship contained 0·007 per cent. phosphorus and 0·03 sulphur, so that it was pure enough to meet everybody's requirements, as far as the metal itself was concerned, but it had corroded for the reason stated. In another case of a ship built with steel containing 0·04 to 0·05 per cent. sulphur and phosphorus the paint again was to blame. The shipowner scrapped all the original paint, covered the ship with white lead and then painted it again, with the result that all corrosion had been stopped. That demonstrated the desirability of adequately protecting the metal with good paint. In one instance, mentioned in the report, the Committee gave the proportion of carbon in the affected and unaffected portions of the steel as about the same. How was it there had been no alteration in the carbon content when the sulphur and phosphorus in the pitted portion had increased from 0·021 and 0·042 to 0·082 and 0·084 respectively.

Dr. N. P. Inglis, speaking with regard to the effect of copper in mild and ordinary steels, gave the results of some tests he had recently carried out. The metals tested were mild steel, Armco iron, and two steels, one containing 0·3 per cent. copper and the other 0·48 per cent. copper with about 0·15 per cent. molybdenum. Atmospheric tests were carried out for a year on the top of the main offices of a large chemical factory, where a real industrial atmosphere existed. As regarded the actual loss in weight by corrosion, there was nothing to choose between the mild steel and the Armco iron, but the 0·3 per cent. copper steel gave a higher loss in weight than the copper-molybdenum steel. In all cases, however, the copper steels had extraordinarily resistant scales which were extremely difficult to remove. In such cases painting would not be much of an advantage, because the scale would not be likely to flake off and take the paint with it. Whilst water corrosion was not relevant to the present work of the Committee, it might be interesting to state that some steels tested in Tees River water showed very little reduced corrosion owing to the presence of copper, but with copper and a small percentage of molybdenum there was an appreciable effect in reducing corrosion, and it seemed worth while having that small percentage of molybdenum. The question of contact effect had been mentioned, and his experience had been that some of the worst corrosion effects by contact had been found in the case of some of the special corrosion-resisting materials in contact with mild steels, which was quite a common state of affairs.

Dr. Walter Rosenhain said that it was all very well to say, as some had been obliged to say, that there was no accelerated corrosion test which gave absolutely reliable results for service conditions, but some form of test had to be found. The evaluation of the amount of corrosion was an old subject and had been discussed many times, and he was pleased to know that the Committee proposed to make tests on the mechanical properties as well as on the change of weight. That was a method which Dr. Hatfield had adopted for other purposes, and work had also been carried out on those lines at the N.P.L. in connection with the corrosion of steel at high temperature in furnace gases. Some interesting results of a preliminary character had been obtained in that work, and they had a considerable bearing on the manner in which corrosion could best be tested. The material in that case was made as wire and heat treated in such a way as to have a micro-structure of the same type as the original plate. The test of corrosion was done by taking pieces of the wire from the furnace at intervals of a fortnight, making tensile tests and measuring the change of electrical conductivity. A very good correspondence between the two was indicated, but the tests suggested that corrosion was irregular and for that reason there was a distinct difference between the actual numerical values obtained by the two kinds of tests. As to the change of weight due to corrosion, a method of removing the products of corrosion without affecting the actual weight of the steel itself consisted of pickling in dilute acid, the action of which was inhibited by quinoline. That was a more reliable way than any mechanical method he knew. The test pieces used in the field tests seemed to him not to have been altogether wisely chosen. The ratio of surface to weight was comparatively small, and fortunately that was the state of affairs experienced in practice, but he doubted whether that relationship should be adhered to for testing purposes. The test pieces might be rolled down even to ¼in. without affecting corrosion resistance.

Mr. James Henderson said that the material used in the field tests was not made in a special way for the purpose of those tests. It was true that the furnace conditions were specially observed during manufacture, but the composition of the steel was normal and represented the average of many millions of tons made in this country.

Dr. Hatfield, replying to the discussion, expressed the hope that both Mr. Service and Dr. Inglis would give, in writing, fuller details of the instances they had quoted. The fact that the corrosion of ships' plates had been shown to be due to something other than the steel was a very big subject, and the Committee hoped to go thoroughly into that at an early date. The effect of stress, mentioned by Dr. Inglis, was also a very big problem and had not yet been dealt with, but there was no reason why it should not be done in a few examples. But the number of samples necessary to cover only one steel was so considerable that the Committee had so far hesitated to go beyond the scheme laid down. He promised Dr. Rosenhain to try and prepare an intelligent abstract of the report. As to the size of the test pieces, that was largely governed by the commercial form in which the steel was produced. In conclusion, Dr. Hatfield said it was the ambition of the Committee that the result of its work should be the extension of the use of mild steel into many fields where at present other materials were used.

A cordial vote of thanks was passed to Dr. Hatfield, Mr. Evans and Dr. Hudson.

The final paper taken on May 7th was one on "The Constitution of Scale," by Dr. L. B. Pfeil.

THE CONSTITUTION OF SCALE.

The investigation described in this paper was carried out as a continuation of a study of the fundamental facts associated with the oxidation of iron and steel and consists mainly of a study of the microstructure of pure iron oxide, but includes also some determinations of the freezing points of iron oxides of various compositions. After a discussion of the difficulties encountered in the preparation of pure iron oxide, the results of experiments upon the liquidus of the iron-oxygen system from FeO to Fe_2O_3 are given. Photographs of the microstructure of the FeO–Fe_2O_3 system are included, with the conclusions to be drawn from them, and finally the structure of scale deposits is examined. The conclusions drawn from the investigation differ from those of other workers, particularly with regard to the existence of a eutectic between FeO and Fe_2O_3, which was reported by Oberhoffer and d'Huart, by Wyckoff and Crittenden, and by McCance.

Sir Harold Carpenter, F.R.S., said the paper dealt with a very difficult piece of experimental work, and the author had done well to put together the diagram of the system in so far as it had at present been determined. The author had hinted that iron oxide was a very reactive substance; it was, as a matter of fact, extraordinarily so, and the great difficulties which the author had had to contend with should be recognised.

Mr. A. B. Winterbottom expressed the hope that the paper was the prelude to the further study of scale-resisting steels. In de-scaling it was of importance to know the constitution of the scale; in the study of pickling, too, a knowledge of the constitution of the scale might help in diagnosing the previous history of steels that had failed when scale was present.

A vote of thanks to the author, who will reply in writing, closed the day's proceedings.

(To be continued.)

Electrification of the Manchester-Altrincham Railway.

No. I.

THE electrification of the Manchester, South Junction, and Altrincham Railway, which was inaugurated on Monday, May 11th, marks a noteworthy stage in the electrification of British railways, as it is the first section which employs the 1500-volt D.C. overhead contact collection system, with a running rail return, recommended in the Railway Electrification Committee's Report—1927—to the Minister of Transport.

The railway, which is jointly owned by the London, Midland and Scottish and the London and North-Eastern railways, is 8¼ route miles in length, with a total single track mileage, including sidings, of 28 miles. It runs through almost level country, and there is only one short tunnel, while the route is comparatively straight, as will be seen from the map, Fig. 1. There are ten intermediate stations with an average spacing of about ¾ mile.

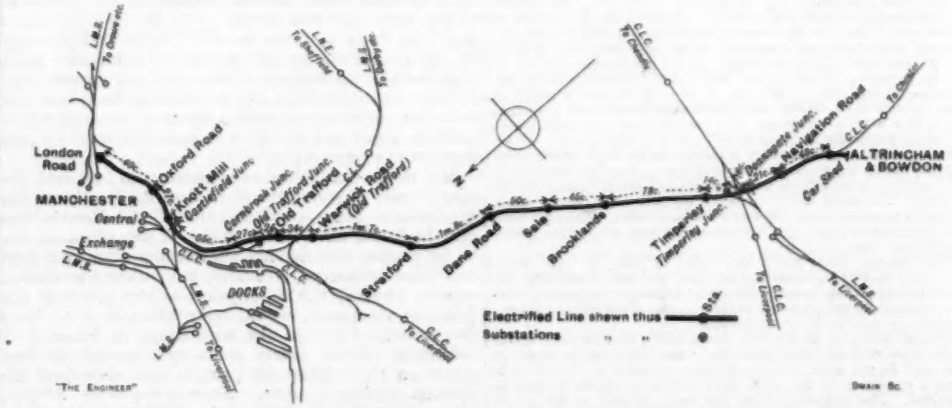


FIG. 1—ROUTE OF THE MANCHESTER, SOUTH JUNCTION, AND ALTRINCHAM RAILWAY

For eighty years the line has been worked by steam locomotives, and the best time for the journey was then 27 minutes. Now, with two additional stations to stop at, the electrical trains do the journey in under 24 minutes, and 124 trains can be run in a day instead of 99.

A supply of electricity in bulk is taken from the Longford Bridge sub-station of the Stretford and District Electricity Board, at 11,000 volts, three-phase 50 cycles, and is converted in two railway sub-stations to 1500 volts D.C. The sub-stations are at Old Trafford and Timperley, so that they are 5¼ miles apart. The supply to these two sub-stations is transmitted from Longford Bridge by duplicate 11,000-volt cables, by Callender's Cable and Construction Company, supported on creosoted wooden stumps alongside the permanent way.

The sub-station equipment was supplied by the British Thomson-Houston Company, Ltd., of Rugby, and provides for a total output of 4500 kW at each station, with an overload capacity of 25 per cent. for two hours; but there is some difference in the two plants. That at Old Trafford might be described as headquarters and is staffed throughout the twenty-four hours. The Timperley station is unattended, and is controlled from Old Trafford. The connections

for this purpose are carried on the same stumps as the high-tension cables.

The principal items of the equipment at Old Trafford are a 1500-kW rectifier—Fig. 6, p. 544—and two rotary converter units of 1500 kW each, all of which are hand controlled. At Timperley there are three rotary converters with automatic starting gear—see Fig. 4. There are, of course, a number of auxiliaries in both sub-stations. Each rotary converter unit is really two machines, of 750 kW and 750 V, connected in series, to get the desired voltage.

At each sub-station a bank of metal-clad, compound-filled switchgear is installed for controlling the 11,000-volt, three-phase, 50-cycle A.C. supply—see Fig. 5. Each bank of switchgear comprises oil switches for the control of three converting units, an auxiliary transformer and two incoming feeders, together with a bus coupler and a blank equipment for a further converting unit which may be required in the future. At Old Trafford sub-station the whole of the switchgear is arranged for manual operation, whilst at Timperley sub-station the switches controlling the supply to the three converting units are arranged for operation by means of solenoid mechanisms controlled from Old Trafford.

Each pair of rotary converters is fed from the secondary side of a 1650-kVA oil-immersed, self-cooled, indoor type transformer situated in the substation basement. The 1500-volt D.C. supply obtained from the converting units is fed to the D.C. bus-bars on the positive side, through a machine high-speed circuit breaker, and on the negative side through an air break switch. From the D.C. negative bus-bar, cables are run direct to the earth return rails, and from the positive bus-bar the supply to the overhead equipment is taken through isolating switches and four track feeder high-speed breakers—Fig. 7, p. 544. The machine high-speed circuit breakers are arranged for reverse current tripping only, and will open in the event of a fault occurring on the machines. The feeder breakers are arranged for forward tripping, and will operate in the event of an excessive overload or short circuit on the overhead equipment. The arrangement is therefore such that in the event of a fault on one section of the track the feeder breaker in that circuit will open, but the converting units remain in operation and continue to supply energy to those sections of the track which have not been affected by the fault, thereby restricting to a minimum any interference with train services.

At each substation, a 25-kVA, oil-immersed, self-cooled, auxiliary transformer is installed for stepping down the E.H.T. supply to 415 volts, three-phase, four-wire, in order to provide suitable supplies for lighting and heating circuits and other auxiliaries. A 200-ampère, 110-volt, Chloride storage battery at each sub-station is charged by means of a small automatically controlled motor generator set, the latter being supplied from the 25-kVA auxiliary transformer. In order to provide maximum reliability of the supply for battery-charging purposes a standby motor generator set is installed, and an additional 12½-kVA auxiliary transformer is provided at each sub-station. This small transformer receives its primary supply from the slip-rings of one of the rotary converters, and in the event of the failure of the 25-kVA transformer the supply for the motor generator set may be taken from the secondary side of the 12½-kVA unit. The batteries furnish a supply for various control circuits, and also for the emergency lights which are automatically switched on should any failure occur to interrupt the supply to the main lighting system.

A Sturtevant combined vacuum cleaning and blowing equipment is provided in each sub-station—Fig. 8—and pipe connections are run to convenient points in each building, so that the machines and switchgear may be readily cleaned and kept free from dust and dirt. A portable de Laval oil purifier is provided, which may be transferred from one sub-station to the other.

The plant at Timperley sub-station is controlled by the attendant at Old Trafford by means of the Midworth distant repeater system of Evershed and Vignoles—Fig. 9, p. 544. It comprises a transmitting instrument at Old Trafford and a receiving instrument at Timperley, the two control panels being connected by means of a pilot cable between the sub-stations. In the event of a failure of the interconnecting pilot cable, or of any portion of the remote control apparatus, the arrangements are such that an attendant can enter Timperley sub-station and carry out the necessary operations for the starting of the converting equipments and the control of the feeds to the various tracks. Under normal conditions of operation the Old Trafford sub-station attendant controls the plant at Timperley by means of the remote control gear, and he is enabled to start up or shut down converting units as required. Instruments are also provided on the remote control panel so that the operator may obtain indications from the distant station of the bus-bar voltage, machine voltage and the current output of the converting units. In addition, he can obtain indications of the position of the E.H.T. oil switches, the machine breakers and the feeder breakers.

The steel tank mercury arc rectifier installed at Old Trafford sub-station is noteworthy, as it is the first instance of the application of a 1500-volt rectifier to British railway electrification. The equipment, which is entirely of British design and manufacture, embodies many new features which may exercise an influence on future installations where heavy loads have to be dealt with.

The rectifier—Fig. 6, p. 544—is a twelve-anode machine and the mercury vapour vacuum pump and rough vacuum pump are carried on the rectifier itself, so that all vacuum connections are made independent of the setting up of the rectifier on site. The vacuum chamber is fabricated from steel plates welded by the atomic hydrogen method, and is enclosed by a jacket through which cooling water is circulated. The main supply of cooling water is controlled by a thermostatic water valve, which opens with rising temperature and thus maintains constant temperature and maximum economy of cooling water. All vacuum seals on the rectifier are sealed with mercury, which enables a tight joint to be made without involving any heavy stresses, whilst, in the event of a seal developing a leak during service, an immediate indication of the location of the leak is readily obtained. The ignition and excitation is on the A.C. system, the current being furnished by a small auxiliary transformer set. Polyphase excitation is employed, which enables the rectifier to carry small loads with certainty, even down to the load taken by a voltmeter, and this can be accomplished without any sacrifice of arc-back protection. The rectifier is sunk through a hole in the sub-station floor so that its upper parts, including the

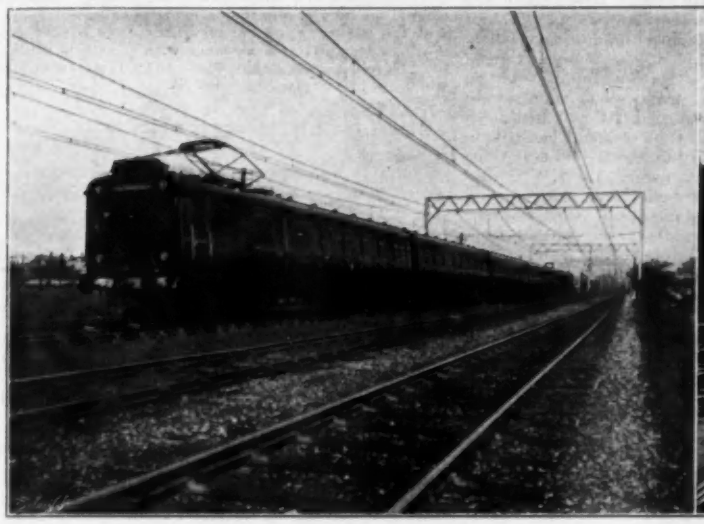


FIG. 2—SIX-COACH TRAIN AT MERSEY BRIDGE

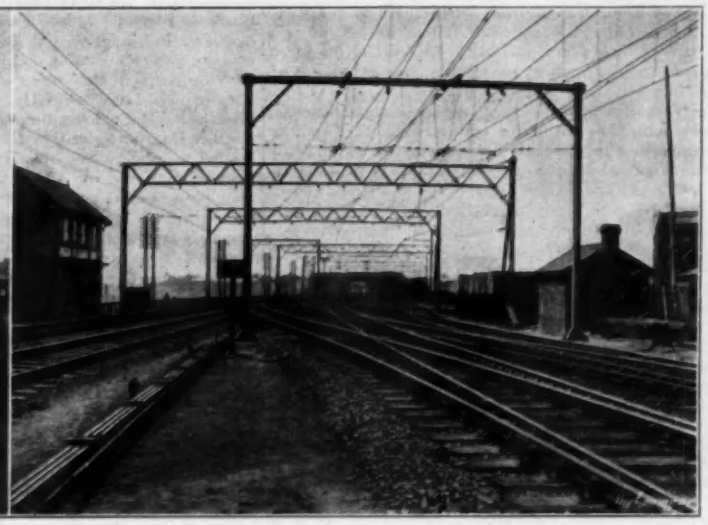


FIG. 3—LINE AND OVERHEAD EQUIPMENT AT WARWICK ROAD

FIG. 4—ROTARY CONVERTERS AT TIMPERLEY

FIG. 5—HIGH-TENSION, THREE-PHASE SWITCHGEAR

vacuum seals, can be inspected, whilst the cathode and main connections are accessible in the basement.

In order to prevent any interference with telephone circuits owing to the ripple in the D.C. voltage wave produced by the rectifier, a smoothing circuit is provided. This circuit consists of a D.C. reactance in series with the rectifier on the D.C. side and four resonant shunts connected across the D.C. load. With this equipment the harmonics in the D.C. voltage are reduced to a value which has been found from experience to cause no telephone interference.

The structural work for the overhead equipment, all of which was supplied by Callender's Cable and Construction Company, Ltd., requires little comment, as it is well illustrated in Fig. 3, and it seems sufficient to say that it generally consists of I section columns, with spans of channels bolted together back to back. The design of the structure is, however, naturally dependent on local circumstances. Anchor structures are arranged at approximately one mile intervals.

The suspension system for the conductor, it will be seen, comprises a main catenary wire, which is carried from the gantries by suspension type insulators. From this catenary wire there is supported, by long droppers, an auxiliary catenary wire. Finally, the conductor is carried by the auxiliary catenary by short loops arranged at short intervals.

The density of traffic necessitated a sectional area equivalent to 0·85 square inche of copper in the overhead conductor system. This construction, so far the heaviest in Europe, presented certain problems, as it was necessary to split up the area into conductors which were small enough to be handled without interference to traffic, and at the same time provide ample strength under the worst possible conditions of ice and wind loading. In addition, a very flexible suspension was imperative to allow of perfect current collection at the high running speed of approximately 60 miles per hour. These conditions were met by making both the catenary wires and the trolley wire conductors. They are all of copper and the catenaries are stranded, while the trolley wire is solid. It is of circular section with V grooves in the sides to take the hanger clips. The cross-sectional area of the trolley wire is 0·25 square inch, of the auxiliary catenary 0·225 square inch, and of the main catenary 0·375 square inch.

The trains—see Fig. 2—are composed of vehicles of the compartment type, seating 72 third-class per motor car; 48 third-class and 40 first-class per trailer car, and 108 third-class per driving trailer car, or a total of 40 first-class and 228 third-class seats per three-coach train. A luggage compartment is also provided on each motor coach. The Westinghouse brake system is employed. The length of a three-coach train is 185ft. over buffers, and each vehicle is 58ft. long over the underframe. The total weight of a three-car train is approximately 118 tons, exclusive of passengers. At present 24 motor coaches, 22 driving trailer coaches and 22 trailer coaches are electrically equipped. Each of the 24 motor coaches has four 330 H.P. motors mounted, two in each bogie, giving a a total of 1300 H.P. per motor coach. The coaches have been built by the Metropolitan-Cammell Carriage, Wagon and Finance Company, and the electrical equipment supplied by the General Electric Company, of Magnet House, Kingsway, London. This equipment, which is unusually interesting, will be described in a subsequent article.

A repair shop has been provided at Altrincham and is fitted with a 25-ton overhead travelling crane by the Clyde Crane and Engineering Company, and two electrically operated bogie traversers by Joseph Booth and Sons, Ltd. Machine tools of various kinds, work benches, stores, &c., have been installed and the shop will be capable of carrying out all repairs, adjustments, maintenance work, &c., which may be necessary on the electrical equipment from time to time. Motor generators, which take power from the 1500-volt line, supply current for shop purposes at 110 volts, and plug connections are provided in the repair shop and in the carriage shed, so that connection from this supply may be made direct to any motor coach for the purpose of testing the control equipment.

The introduction of the electrification necessitated the removal of five signal gantries, together with the East signal cabin at Oxford-road Station. These structures spanned the line, and were not sufficiently high to clear the overhead electrification equipment. By the provision of track circuiting at the London-road end of Oxford-road Station, it has been possible to deal with the operation of all points and signals at the station from the West cabin. The signal gantries referred to have been replaced by separate posts fixed on each side of the viaduct. In these positions, however, the overhead electrification equipment considerably interferes with the drivers' sight of the signal arms, and, in consequence, Adlake Corning-Lebby electric lamps, with a luminous intensity of about 20,000 candle-power have been provided to serve as day and night signals. At various points between Oxford-road and Altrincham it has been found necessary to alter either the structure or position of a number of signals, owing to the overhead equipment. In some cases, in this section, the obstruction to the drivers' sight has necessitated the provision of Adlake Corning-Lebby lamps.

(To be continued.)

DINNER OF THE IRON AND STEEL INSTITUTE.

THE annual dinner of the Iron and Steel Institute was held on Thursday evening, May 7th, at the Connaught Rooms, with the President, Sir Charles Wright, in the chair. In spite of the serious depression prevailing in the industry, a company of members and guests numbering over 360 was present.

The toast of "The Iron and Steel Industries" was proposed by Lord Weir of Eastwood, who referred to some criticisms which had been passed on the industry by those who, he suggested, had never had the task of administering a productive industry. The need of the industry, Lord Weir went on to say, was not so much reorganisation, as suggested by some members of the Government, but a lessening of the burdens placed on it. Protection was needed, not against the foreigner, but against the defective policy of our own statesmen. One of the most advanced developments of the policy of State-nominated control—of which he was justly proud—was the Central Electricity Board, but he regarded the constitution of similar Boards to deal with the steel and the cotton trades as one of the most dangerous hallucinations ever entertained by a Government. Lord Weir said that he was a realist, and he believed in safeguarding the interests of both the men and the industry through the mechanism of industry as distinct from politics. The Right Hon. John Hodge, in his reply, referred to some suggestions of his own in earlier years with regard to international fair wages, and he put forward the idea that four shifts in twenty-four hours would employ productively more men than the present three-shift system. Rationalisation, he thought, might be good in some instances if too much was not paid for derelict concerns. The toast of "The Guests" was ably proposed by Sir Hugh Bell in one of his characteristically happy speeches, and in his reply Sir Hugo Hirst referred to the recent Weir report on railway electrification. He recalled the contributions made by electrical engineers to the iron and steel industrial developments of recent years, and asked for a careful and objective consideration of the railway electrification problem, which, if taken in hand, would, he said, mean very much to our steel and engineering industries. After the Napoleonic wars steam had saved this country, and he felt that cheap electricity was coming to Britain's rescue after a much greater catastrophe. The toast of "The Iron and Steel Institute" was proposed by Sir Robert Horne and the President replied.

Notes on Marine Oil Engine Seatings.

IN a paper recently read before the North-East Coast Institution of Engineers and Shipbuilders on Marine Oil Engine Seatings, Dr. J. Montgomerie, the chief ship surveyor of Lloyd's Register of Shipping, discussed the nature of the stresses imposed on the seatings of oil engines, as compared with those of steam engines, and the various problems which have confronted the designer in the course of the increasingly rapid development of this type of propulsion. Detailed sketches of ten different forms of seating which have proved unsatisfactory were given, together with particulars of the nature of the trouble experienced in each case, and the corrective measures adopted. The following are the general conclusions drawn by Dr. Montgomerie as to the requirements and conditions which must be satisfied in the design and construction of such seatings:—

(1) The top plates should be as broad as possible. The breadth should not be limited merely by the amount necessary to take the holding-down bolts. Its importance lies in the facility which it affords for increasing the amount of riveted attachment at the top.

(2) The transverse brackets should have as broad a base as possible, and the riveted attachments of these, especially at the top, should be ample. Experience has shown that, at the top at least, it is hardly possible to err in the sense of providing too much. The brackets should in all cases be stiffened on the edges, and in some of the earlier cases the necessity for this was not sufficiently appreciated. This is not a matter for surprise, since the brackets in themselves appeared to possess sufficient rigidity on account of their shape and thickness.

(3) Attention should be given to the disposition of the girders in the double bottom under the seating. It is, of course, usual to place one of the upper girders in the same plane as the girder in the double bottom; but it has been found advantageous to increase these in number in some cases.

(4) The thrust seatings and the auxiliary seatings should be incorporated as far as possible in the main construction Further, the seatings should be continued to the bulkheads and securely attached thereto. If considerations of space permit, there should also be a continuation of the structure beyond the bulkheads, but this is not often obtained on cargo vessels, although easily arranged in tankers.

(5) Cross ties between the longitudinal girders are no longer thought necessary.

(6) The workmanship should be of the very highest quality. Questions of workmanship sometimes tend to produce divergent points of view; but no one will dispute the necessity for the highest standard in this case. The actual procedure adopted naturally varies in different districts, but a common practice is to punch the holes in the plates and angles a size small, and drill to full size after adjustment. Another method is to punch sufficient holes to screw up, and then to drill throughout. The service bolts used should be of the same diameter as the holes. Before riveting is commenced, it is essential that all steel particles and drillings should be removed from between the surfaces, and this is generally effected by slacking back the work and removing the particles by a steel feeler. In some instances, particularly on the Continent, the surfaces are cleaned by an air blast. In all cases the riveting at the skids should be done by hydraulic machinery, and, wherever possible, the riveting at the ship should be executed by a portable hydraulic riveter. With a view to ensuring accurate fitting, it has become a frequent practice to fit the plates a little proud, and then chip them flush after riveting. Some differences of opinion have been expressed as to the practical value of this procedure, and doubts have been raised as to whether the expense involved is justified in view of the difficulty of exact adjustment.

The above-given measures are the fruit of observations carried on by Dr. Montgomerie during the last 15 years, and the general result of their adoption is that engine seatings designed in accordance with the modern practice may be relied upon satisfactorily to fulfil the functions for which they have been designed.

SIXTY YEARS AGO.

IN our issue of May 19th, 1871, we recorded the birth of a new society, the Society of Telegraph Engineers. A preliminary meeting had been held at 2, Westminster Chambers. At that meeting the constitution of the Society had been settled and seventy-three members, including most of the eminent electricians and telegraph engineers of the day, had been elected. There was, we said, perhaps no branch of civil engineering which had so rapidly and successfully raised itself into eminence as that which had telegraphy for its object. The Society of Telegraph Engineers established "for the general advancement of electrical and telegraphic science," soon found that telegraphy was not the most important branch of its subject, and in due course it became the Institution of Electrical Engineers. . . . On May 11th, 1871, Sir John Herschel died in his eightieth year. We published a lengthy account of his life and work, for he was in his own time hailed as one fit to rank with Bacon and Newton. Some there were who disagreed heartily with his metaphysics, but few dared to challenge his astronomy. So implicitly did most people believe in him that when he was reported by the *Edinburgh Journal of Science* to have discovered that the moon was inhabited, many people were deceived by the hoax. Numerous sermons were preached on a text so suggestive and edifying, and from clergymen in America Sir John received several inquiries concerning the possibility of science affording any prospect of a method of conveying the Gospel to the residents in our satellite. From our account of his life it is difficult to find any outstanding reason why Sir John Herschel should have acquired the scientific reputation which his generation almost unanimously accorded to him. He was a mathematician, in conjunction with James South he compiled a catalogue of 380 double and treble stars, he was a chemist, an electrician, natural philosopher, metaphysicist, and a poet. His chief literary work was the "Preliminary Discourse on the Study of Natural Philosophy," and it was largely, if not entirely, to the popular esteem in which that book was held that he owed his reputation as a scientist. It was not he, but his father, Sir William Herschel, who built the great telescope at Slough, who discovered the motion of the binary stars, who studied the constitution of the milky way, who speculated on the nature of nebulæ, who was and is, Herschel the great astronomer. In his generation the son, as an expositor of science and philosophy, seemed to many people to be a greater man than the father. In the annals of science, however, the father's work will be remembered long after it has been forgotten that there was a son. . . . On April 25th, 1871, a curious contest took place in America. Two railways disputed each other's right to run trains on a certain line at Peoria, Illinois. One company blocked the line by standing cars upon it. The other tried to force a passage by means of a heavy train headed by five locomotives. The rival company replied with a force of three engines. For an hour the two contestants butted against each other. Eventually the five-engined train cleared the line. The police refused to interfere, and it was decided that neither company should use the line until the courts had settled the rights of the case.

SOUTH AFRICAN CONTRACTS FOR BRITAIN.

THE International Telephone Company has secured a million pound South African contract to be executed at its Liverpool works. The first consignment of material for the automatic telephones arrived in South Africa in February, accompanied by eight young South Africans who have spent a year training in the company's works, and who will serve as a nucleus of the automatic telephone engineering staff in the Union. Among the recent orders placed by the South African Railways and Harbours Administration with British firms, through the High Commissioner's Office in London, is one for 220 track miles of rails, together with their contingent requisites. All these rails, which will comprise 96 lb., 80 lb. and 85 lb. classes, are for use on main lines. Further orders for sleepers and other accessories necessary to complete the track have also been placed. In this connection 250,000 steel sleepers, weighing in all over 15,000 long tons, have been ordered from one British firm alone at a cost of £82,560, while accessories weighing 1630 long tons and costing nearly £26,000, have been ordered from other British firms for use with these sleepers. Orders have also been received by continental firms for 355,000 steel sleepers for use with the 60 lb. rails at a cost of £75,000. All costs are f.o.b.

The General Electric Company's High-Tension Works and Laboratory.

FEW engineers imagined some twenty or thirty years ago that electrical manufacturers would ever be called upon to produce such things as they are producing to-day. Looking back at the early electricity supply systems, it is almost unbelievable that such remarkable changes have taken place in so short a space of time, and that all modern developments are the outcome of Faraday's discoveries of only one hundred years ago. Even comparatively young engineers have witnessed remarkable changes which outclass developments in most other industries. In 1904 a 1500-kW turbine was considered large; in 1914 the output had increased to 12,000 kW; to-day 60,000 kW machines are being provided to meet the needs of electricity supply in this country, whilst compound machines of 160,000 and 200,000 kW are in actual use in America. Coupled with these developments there have, of course, been others, which have called for engineering skill of no mean order. With the increasing size of generating units and of stations and the rise in transmission pressures a demand has arisen for equipment capable of handling heavy loads continuously at pressures up to 220 kV. Anyone who visits a large electrical works to-day and who sees the large and massive switches and transformers and other equipment under construction cannot fail to recognise that the days of taking chances are gone and that manufacture must be backed by tests and experiments in order to ensure that the equipment will stand up to its work.

Although in the past most of the large electrical manufacturers have made large switches and transformers for use on high-pressure systems abroad, since the work on the national scheme was put in hand the demand for apparatus of this kind has naturally increased and special arrangements have had to be made to cope with it. While the General Electric Company, of Witton, Birmingham has long possessed one of the largest and most up-to-date switchgear works in the country, it has been necessary to build a separate works to meet the demand for switchgear working at pressures up to 220 kV and for transformers up to 100,000 kVA at 132 kV. The firm has also provided itself with a high-tension laboratory laid out in accordance with the latest scientific principles and designed not only for the routine testing of manufactured apparatus, but also for the comprehensive investigation of high-tension phenomena. Within a few weeks of completion the new works were in full swing and are now dealing with important contracts both for the home and overseas markets. The new H.T. factory consists of a well-lighted single-storey building situated on the west side of the original switchgear works and covers an area of approximately 110,000 square feet. The offices, including the drawing-office, are grouped at the north end of the works, whilst the stores are adjacent to the general offices and run east and west or transversely to the main shops. Direct access to all departments is thus obtained in a most convenient manner, the lay-out being arranged to secure a regular flow of materials from north to south. Goods in the form of raw materials are delivered to the receiving stores situated next to the north-east corner of the works. The new factory proper is divided into six bays, each 350ft. long and running north and south.

Starting at the east side, the original switchgear factory is separated from the new works by a court-yard, where there are stores for angle and channel iron for the manufacture of switchgear and transformers. A boiler plant in an annexe supplies steam at 165 lb. per square inch for the drying rooms, compound melting plant, vacuum impregnating plant and various calorifiers, and oil-fired hot water heaters are provided for warming the building. The first bay at the extreme east is devoted to the storage of tanks for oil circuit breakers, transformers, &c., and a number of cubicles are provided for welding operations. The next bay is equipped with modern machine tools with individual motors and press button control. In both of these bays overhead travelling cranes of 5 tons capacity are provided. In the third bay, which is 60ft. wide and 30ft. 6in. in height to the crane rails, large switch units and switchboards are erected, and the capacity of the crane in this case is 15 tons in order that it may deal with the large 1,500,000-kVA "grid" circuit breakers and large metal-clad switchboards, &c.

The remaining bays, which constitute the major part of the works, are devoted to the manufacture of transformers, the larger units being erected in the largest of the three bays, which is 350ft. long, 60ft. wide, and 30ft. 6in. in height to the crane rails. The equipment of this bay includes two 30-ton cranes, which can operate simultaneously as a single unit. On the east side of this bay there is a bay 60ft. wide, split into two parts, each 30ft. wide, in which the work of winding transformers is carried out on large winding lathes capable of accommodating coils up to 9ft. long and 6ft. in diameter. There are also pedestal machines for winding cross-over coils and small high-tension coil winding machines mounted on the benches. On the west of the central transformer bay there is a 30ft. bay, in which small transformers are assembled, and this bay is equipped with a 5-ton crane.

At the south end of these bays there are seven steam-heated ovens, vacuum impregnating plant, oil storage tanks, oil treatment apparatus, and the testing departments, including the high-tension laboratory. Of the seven ovens, four are capable of stoving the largest transformers that are built at Witton. Oil is stored in eight 3000-gallon tanks and the pump-

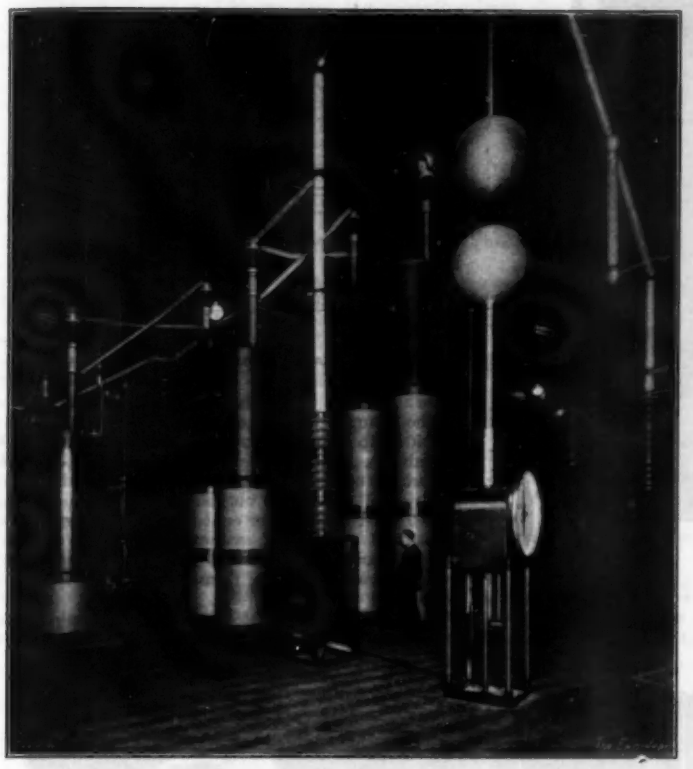


FIG. 1—MILLION VOLT CASCADE CONNECTED TRANSFORMER

FIG. 2—ELECTRICAL AND MECHANICAL STRESS TESTING MACHINE

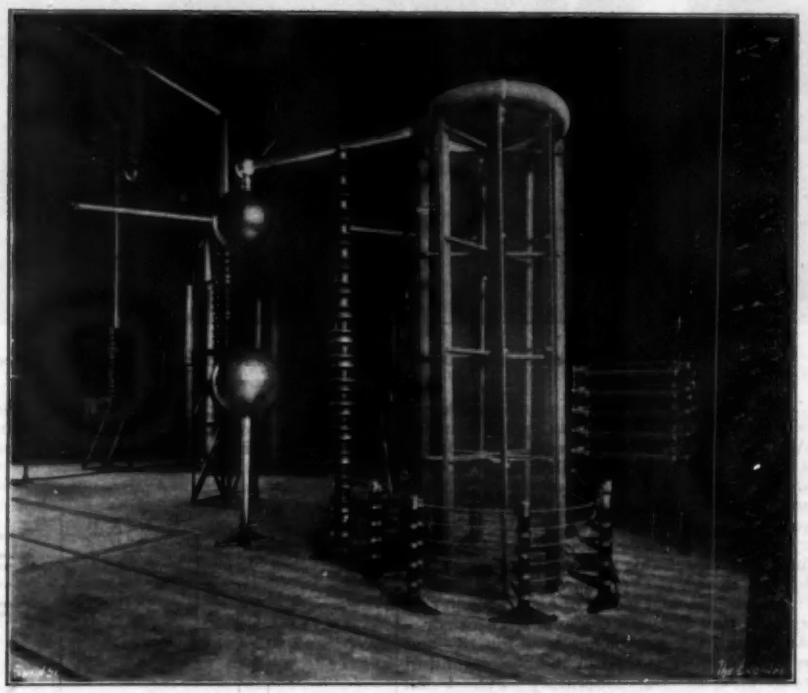


FIG. 3—TESLA COIL HIGH-FREQUENCY GENERATOR

ing equipment, which operates in conjunction with these tanks, is capable of dealing with 5000 gallons of oil per hour. Oil cleaning and filtering plant is also provided. For testing transformers there is a pit 10ft. deep and generators, transformers and control gear for supplying the power are arranged adjacent to the pit. The capacity of the testing plant is sufficient to enable full-load tests to be made on units up to 30,000 kVA. For over-potential tests a 2500 kVA, 150-cycle generator has been installed and a special feature of the test equipment is that the switchgear and all leads to the machines are totally enclosed.

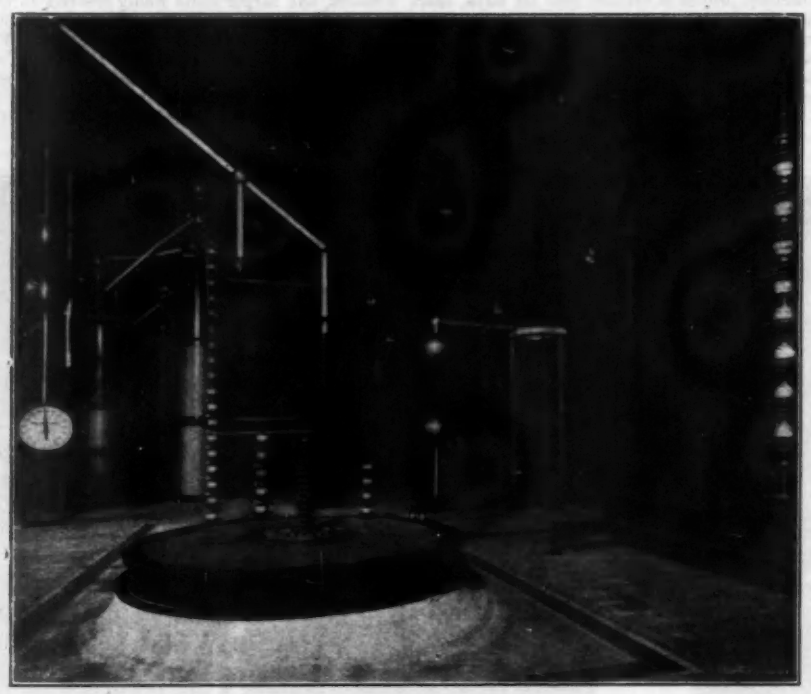


FIG. 4—GENERAL VIEW OF HIGH-TENSION LABORATORY

Adjacent to this testing pit is the high-tension laboratory, which enables a complete study to be made of the behaviour of insulating materials and apparatus when subjected to electrical pressures up to 1,000,000 volts. The three principal pieces of apparatus in this laboratory are the 50-cycle cascade transformer—Fig. 1—the high-frequency generator—Fig. 3—and the surge generator, to be seen in the background of the general view of the laboratory—Fig. 4—all capable of giving 1,000,000 volts. In the foreground of Fig. 4 a large heated oil tank is shown, which is used for testing insulators while they are immersed in oil at any desired temperature, whilst Fig. 2 shows an electrical and mechanical testing machine which enables high voltage tests to be made on apparatus and materials while under mechanical stress. The connections for the cascade connected testing transformer shown in Fig. 1 are given in Fig. 8. This arrangement forms the subject of the Dessauer patent, the British rights of which are held by Ferranti, Ltd., who built the transformers shown in Fig. 1.

The main objects of the Dessauer arrangement are to avoid the use of very high-voltage bushings and to reduce the voltage between windings and between the windings and the core and the tanks of the individual transformers. Each transformer is designed for a normal pressure of 250 kV, thus giving 750 kV with the three in cascade, but they are insulated to withstand a voltage 33⅓ per cent. greater than this value, so that a total pressure of 1,000,000 volts may be obtained. From Fig. 1 it will be perceived that the three transformers are insulated in different degrees by mounting them on massive bakelite cylinders of different heights, whilst from the diagram of connections—Fig. 8—it will be noted that the mid-points of each winding are connected to the insulated tanks, and if a total pressure of 1000 kV is being generated, the tanks are at potentials above earth of 167 kV, 500 kV, and 833 kV respectively. Moreover, under these conditions the individual transformer bushings are only subjected to a voltage of 167 kV, and can therefore be relatively small and less costly than they would be under other conditions. As the three transformers are precisely alike, any one can serve as a spare. The transformers are auto-connected in the manner shown, and equalising windings are provided to improve the regulation and to lower the impedance. The complete bank is capable of giving an output of 100 kVA for two hours, and as the impedance of the entire combination based on a load of 100 kVA is 6·75 per cent., a large energy output is assured. A dry flash-over at 480 kV, 50-cycles, on a 132-kV post insulator, is shown in Fig. 5, from which the value of the arcing horns will readily be appreciated.

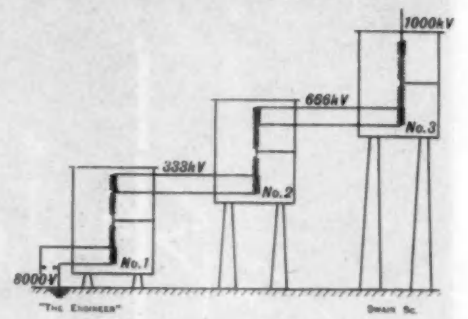
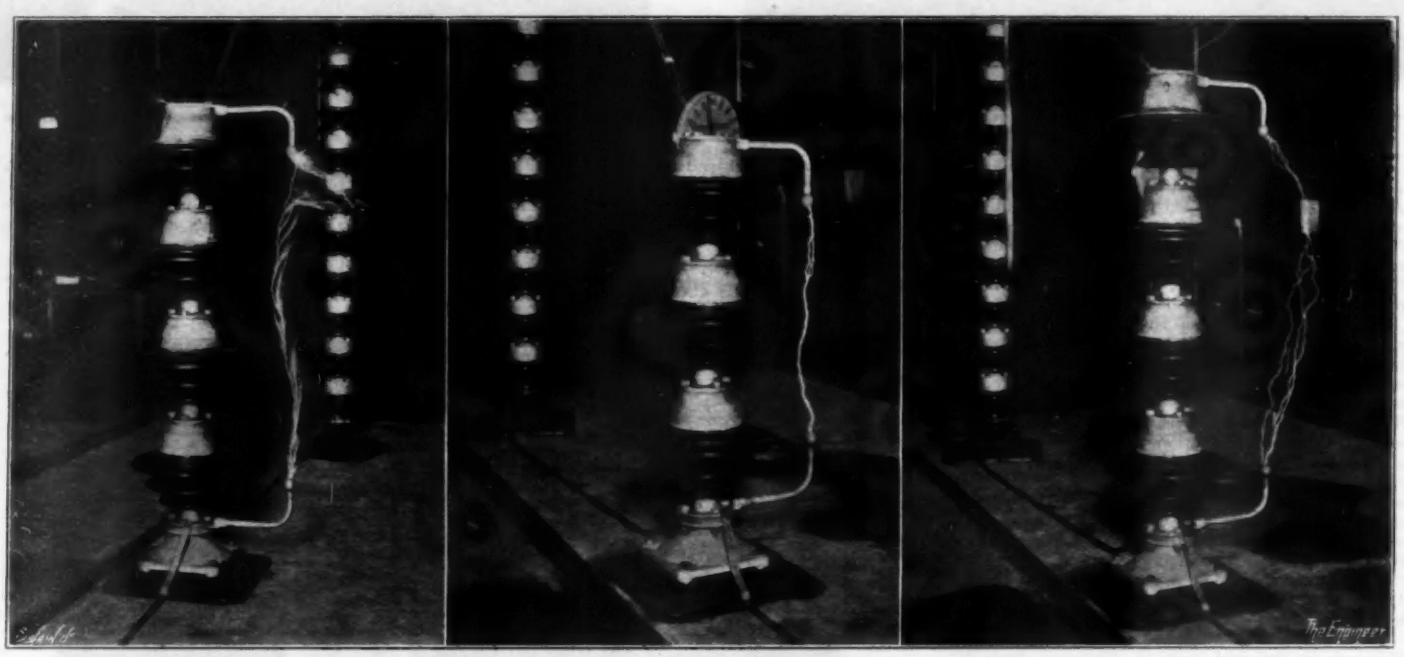


FIG. 8—CASCADE TRANSFORMER CONNECTIONS

It is well known that in addition to high-voltage tests at normal working frequency, it is necessary to test insulators in order to ascertain whether they are capable of withstanding the application of electric surges or impulses, and at Witton the surge generator, which, as we have said, is to be seen in the background of Fig. 4, consists of a number of condensers arranged in accordance with the Marx principle, so



FIGS. 5 TO 7—50-CYCLE, SURGE, AND HIGH-FREQUENCY FLASH-OVERS ON POST INSULATORS WITH ARCING HORNS

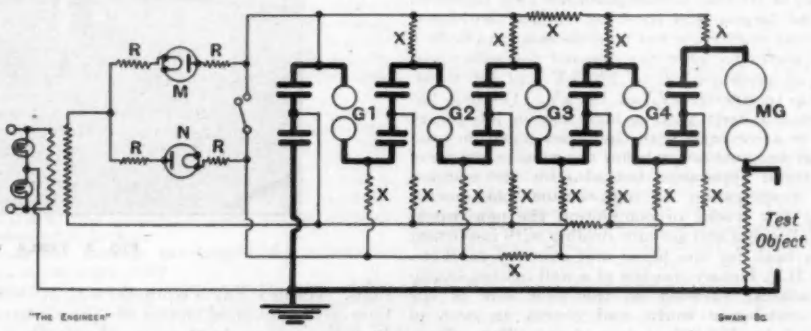


FIG. 9—SURGE GENERATOR CONNECTIONS

that they can be charged in parallel through rectifying valves and discharged at pressures up to a million volts in series. The connections for the surge generator are shown in Fig. 9, where M N are the rectifying valves, X charging resistances of one megohm, R, valve protective resistances, M G the main discharge gap, and G^1 to G^4 the gaps which cause the condensers to be connected in series. A surge flash-over on a three-unit post insulator at 700 kV (maximum) is shown in Fig. 6, whilst Fig. 7 shows a high-frequency flash-over on a 132 kV post insulator at 1000 kV at 125,000 cycles.

Largely as the result of experience with wireless telephony, it is now well known that the behaviour of insulating materials under the influence of high frequencies is altogether different to that under normal frequency. Insulation that is satisfactory under the former condition may be useless under the latter condition, owing to the high internal loss resulting from electrostatic hysteresis. When an insulation material is subjected to a cycle of electrostatic strain, as occurs with every alternation of the testing voltage, it absorbs a certain amount of power, and at 100,000 periods per second this is naturally some 2000 times as great as at 50 cycles, at equal voltage. Hence it is easily seen that if the loss per cycle exceeds a certain value the heat generated, within the insulator, will finally result in failure. Quite apart from the ultimate failure of the insulator, however, the extra losses may prevent the proper action of the apparatus; in other words, a bad high-frequency insulator may not act as an insulator at all. High-frequency tests are useful when applied to composite insulators, as, for example, compound filled porcelain bushes, and enable air voids in the compound to be detected. High-frequency tests are made by allowing the high-frequency energy to discharge across the insulator under test for a certain period, and although it is not generally necessary to measure the value of the voltage of the high-frequency current, this can, of course, be done if required by means of a sphere measuring gap. Usually, however, it is only necessary to ensure that the frequency is above, say, 100,000 cycles per second, and this can be arrived at by calculations based on the dimensions of the testing generator.

The high-frequency generator installed at Witton—see Fig. 3—and the simplified diagram of connections—Fig. 10—consists of an air core Tesla transformer. The primary coil, which is of V cross section, is fed at

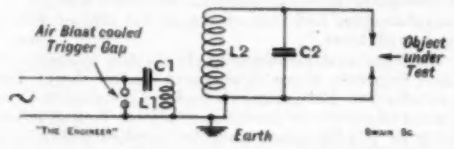


FIG. 10—HIGH-FREQUENCY GENERATOR CONNECTIONS

50 cycles through a condenser and an arc which is cooled by an air blast. In this way a series of high-frequency damped trains are obtained, the successive trains following each other at the rate of 50 per second. The trigger gap of the high-frequency generator is excited from the low-frequency supply, and as the voltage at each period rises from zero, at a certain value of the voltage, an arc forms across the gap and in the meantime the condenser C_1 has been charged to that voltage valve. The arc constitutes a short to the trigger gap, thus forming a closed primary circuit around which the condenser C_1 will discharge, and this discharge will oscillate with a certain frequency. The coils and values of capacity are so chosen that the primary circuit C_1 and L_1 and secondary circuits L_2 and C_2 are in tune, and that this condition is fulfilled is shown by the fact that a high secondary voltage is induced by resonance of the secondary with the primary.

The machine shown in Fig. 2 for combined mechanical tests is of considerable interest, and is used for testing post insulators as employed for the isolating links, &c., in the "grid" open-air sub-stations. It is necessary that these posts should withstand certain specified mechanical pulls longitudinally, at right angles and torsionally, as well as simultaneous vibrations, and the machine is designed so that a high-voltage up to the flash-over point can be applied to the posts while they are subjected to the mechanical stresses. Two complete posts are arranged to pull against one another while the high voltage is applied to the centre point and the machine therefore enables complete post insulators to be tested with ease.

The power supply for all the apparatus is obtained from the transformer test machines previously mentioned, and they are controlled from a desk-type control board situated on a gallery which runs along one side of the laboratory, whilst another gallery at a higher level is provided for the observation of corona and other high-tension phenomena. In view of the fact that it is necessary to carry out many experiments in complete darkness, the walls of the laboratory are perfectly black, and the building is devoid of windows. Access to the laboratory is obtained by raising two roller shutters and by means of a standard gauge railway track, which runs through the laboratory, apparatus may be received from the switchgear and transformer shops, and is handled by the laboratory 10-ton crane. To ensure safety, the working area is screened off from the passageways, and entry can only be obtained through a wicket gate which is interlocked with the main circuit breaker, which controls the testing gear, so that it is impossible for anyone to enter the laboratory whilst the high-pressure apparatus is in use.

During a recent visit which we paid to this laboratory, various high-tension tests were made to demonstrate the operation of the high-frequency and impulse generators, the 50-cycle cascade transformer, and the electro-mechanical testing machine. A needle gap 1000-kV, 125,000-cycle discharge was obtained with the high-frequency generator which was also used to demonstrate the testing of insulators of the post type, as used in apparatus for the British "grid," the flash-over occurring at a pressure of between 700 kV and 1000 kV. Demonstrations were also given by means of the impulse generator of D.C. surges between spheres at pressures of 700 kV and 1000 kV, and a surge test was applied to a 132-kV post type insulator. With the 50-cycle cascade connected transformer, a test was made on a 132-kV "grid" type condenser bushing, which flashed over at about 400 kV when dry and at about 320 kV when sprayed with water. Finally, on the combined electrical and mechanical stress testing machine a 132-kV "grid" post type insulator, fitted with arcing horns, was subjected to simultaneous mechanical and electrical strains, and the flash-over occurred at about 500 kV.

Trade with the Far East.

No. 1.—JAPAN.

ON August 18th, 1930, a British Economic Mission to the Far East was appointed by the Secretary of State for Foreign Affairs and the President of the Board of Trade. The Mission was constituted as follows:—

Sir Ernest Thompson, J.P., Chairman.
Sir Thomas Allen.
Mr. James Bell, J.P.
Mr. William A. Crowther.
Lieut.-Colonel Reginald Morcom, C.B.E.
Mr. Louis Beale, C.B.E.
Dr. S. H. C. Briggs, attached as a representative of the Wool Textile Delegation.
Captain R. T. Nevill, attached as adviser on the tin-plate trade.
Mr. T. St. Quintin Hill, O.B.E., secretary.
Mr. F. A. Barnes, assistant secretary.

Its duties were to inquire into the present conditions of British trade with China and Japan, and to report what action should be taken to develop and increase that trade. It left London on September 19th, 1930, and arrived back in England on April 4th, 1931. Its report, occupying nearly 160 pages, was issued on Tuesday last, or just five weeks after the return of the Mission, a speediness of output upon which everyone concerned deserves to be heartily commended and thanked.

The report is divided into two main sections, one dealing with Japan and the other with China, and several concluding chapters in which the problems are considered from a general aspect, and recommendations are given.

In the present article we reprint excerpts from the Introduction and from the section devoted to Japan.

INTRODUCTION.

The whole of Asia—of which India, China, and Japan are the chief countries—enjoys, as yet, not more than one-seventh of the world's total trade, although possessing almost half of the world's population. China, with nearly one-quarter of the population of the world, secures only 2 per cent., and Japan, including Korea and Formosa, with a population of nearly 90 million, secures only 2·8 per cent. of the trade of the world. In foreign trade—imports plus exports—per head of population, Japan is fiftieth on the list of countries with approximately £6 5s. per head in 1928. India, with a population smaller by 100 million than China, is eightieth on the list with a foreign trade of £1 6s. per head. China, with a population of 400–500 million,* is eighty-second, and lowest on the list with a foreign trade of approximately 12s. per head. If China's foreign trade could be raised even to the level of that of India, the result would be an addition of at least £300 million to the annual foreign trade of the world, in which all countries trading with China would share.

Great Britain's problem as a producer and exporter of goods to the Far East, while not easy, is by no means incapable of solution, as regards China at any rate. Our disadvantages in the Chinese markets are distance from Great Britain, high costs of our production, unintelligent and inadequate methods of distribution—with a few notable exceptions—and, possibly a lack of co-operation between finance on the one hand and production and distribution on the other. It is clear that many British products are beyond the capacity of China to buy in spite of her needs, and they are also often unsuitable and unattractive in themselves. The cure for this state of affairs lies in Great Britain. If we want the China market we must offer what China can afford and wishes to purchase. That market is unlikely to be smaller than it is to-day. Seventy per cent. of the entire population of China is under the poverty line, because of years of internal difficulties, and any improvement in conditions will almost certainly bring about an enlarged volume of trade. There must first be a period in which China's huge and industrious population will have to be equipped with the means of transport and production, a period in which peace in China and financial aid from outside must coincide. The question is whether or not Great Britain is to take a proper share in supplying China with equipment, material, and goods required during this period, which must precede a permanently enlarged market.

Economies in and reorganisation of distribution will help to reduce the price of British goods, but the main contribution to this essential reduction of price must be made by British industry at home, and this is as true of all sections of British industry as it is of cotton goods. As regards the question of suitability and attractiveness of goods, British manufacturers must be less rigid, and be prepared to adjust their processes to the needs and fashions of markets which change with far greater rapidity to-day than they did in the past.

Japan, as a market for our goods, is entirely different from China. We, in common with other sources of supply, shall do well if we maintain our present proportion of imports into that market, for Japan has proved herself to be most capable in carrying out a policy which provides more and more for her own needs in manufactured goods. In contrast with China, there is in Japan little or no market remaining undeveloped.

British export trade to China and Japan to-day, compared with the immediate pre-war years, presents a depressing picture. It is quite true that the war played havoc with the whole of British trade, but to-day, a full twelve years after the end of the war, we find our competitors beating us in supplying the needs of China and Japan in manufactured goods.

In our opinion, the reasons for the failure of Great Britain to maintain her pre-war position in the import trade of Japan and China are to be found in the failure of British manufacturers to produce suitable goods at competitive prices and in defective distribution. Above all, price is the governing factor in Far Eastern trade to-day, and will in all probability be so for many years to come.

JAPAN.

Japan possesses four great factors of prime importance for industrial progress on a large scale. They are (*a*) an intelligent and industrious population inheriting and practising in its daily life a discipline and energy perhaps surpassed by no other country; (*b*) a supply of hydro-electric power both developed and available for future development; (*c*) the largest undeveloped world market, Eastern Asia, at her doors; and (*d*) a geographical position which makes her the natural intermediary between the American and Asiatic continents.

Steel.—Japan has built up a large steel industry, producing more or less successfully almost every description of steel. Her present productive capacity is nearly 2,000,000 tons, of which the largest items are steel bars, 31 per cent.; steel sheets and plates, 28 per cent.; steel rails, 14 per cent.; and steel shapes, 13 per cent. In addition to this production, Japan has to import nearly 1,000,000 tons of steel products, of which 80 per cent. are milled products, chiefly plates and sheets, shapes and wire rods.

Owing to a widespread feeling that the haphazard development during the war and in the boom years that followed has caused production to be unbalanced, and the manifest weakness of Japan's steel industry in competition with other nations, a plan for a nation-wide merger to include the Government Steel Works at Yawata and private companies was started by a Government Committee report in 1925 and is still under active discussion.

As the fundamental idea of this iron and steel merger scheme is to bring up the productive capacity in each direction in which it is now necessary to import, and as over-production is already noticed in many lines, it would seem that steel importers will find it very difficult to secure any but low-price orders, and then only in the lines in which Japan is producing short.

It will be in these same lines that a market may open for import in case of any considerable revival of trade.

But to take advantage of any such openings, it will be essential to have an expert watching for the right moment at which to bring sales pressure to bear.

Where Great Britain still secures trade, as in tin-plates, special steels, and ships' sections, close touch with the actual buyer and close regard for his exact requirements are very necessary, as only thus will there be a reasonable chance of participating in any expansion. The market for iron and steel manufactures in Japan is, however, and will always be, a difficult one for importers. Poor prices will prevail, and quantities of imports will be governed by Japanese production.

Machinery.—The market for machinery in Japan is subject to many of the same factors as that for iron

* The figure issued by the Nanking Government in 1931 was 474,000,000.

and steel, but has also difficulties as well as hopeful points of its own.

That the Japanese industrialist is benefiting from his tuition, is shown clearly by the fact that production of machinery and equipment has reached a figure of close on £60 million out of a total requirement of £70 million, leaving only 14 per cent. for importation. From this it is clear that a state of self-sufficiency is certainly attainable, if Japanese users are satisfied with such a programme.

Discussions, however, regarding the "support home industries" campaign suggest that one industry is not going to allow itself to be handicapped for the benefit of another by using any but the most suitable plant, and it is almost certain that, with a return of the trade expansion movement, a market for imported plant and equipment will again develop. In the more distant future it is possible that the Japanese authorities may realise that, on the whole, the country loses more than it gains in purchasing large quantities of goods at home which are inferior to those which could be imported from abroad. In that event, when trade improves, there may be good openings for machinery sales by those who present a good case and sell in proper fashion. The requirements of Japan for machinery are so varied that any analysis of the market is beyond the scope of this survey, and would merely be repeating what can be found in considerable detail in the annual reports made by H.M. Commercial Counsellor and H.M. Commercial Secretary at Tokyo.

Publicity.—As a people, the Japanese have an innate love of perfection, and though false teaching of the cult of "buy cheap and scrap it" has at present somewhat obscured this, it is probable that in the end the merits of quality will get home to them again, and this will lead to a pro-British trend in trade when they realise the fallacy of the ideal of "not the best, but good enough," so cleverly advertised by our chief competitors.

A further national trait is a love of novelty, and undoubtedly this will lead to demand for electrical applications and other amenities of applied mechanics.

Thirdly, as their standard of living increases, it is generally conceded that the Japanese are good spenders, and this will again make a trend towards a quality market rather than cheap-jack trade.

To take advantage of the market, however, good salesmanship and good publicity should be developed. In the past, British publicity has not only not been good, but has been actively bad. The Japanese are assiduous students of newspapers and magazines, and can hardly be favourably impressed by the statements continually appearing in speeches of prominent public men in Great Britain and in newspaper articles that British industry is behind the times. When it is asked why, in a factory, all the newer tools are American or German, a common reply is, "How can we buy British when British industries are obsolete?" If British public men and British newspapers would stress the undoubted quality and excellence of British manufactures, the effect could not but be favourable to British exports to Japan and elsewhere. It is notorious that any scientific or industrial achievement by America is broadcast, while even more notable or meritorious British successes are never mentioned. Further, the news agencies of competing nations are in the habit of sending out big budgets of technical propaganda which contrast strikingly with the ineffective propaganda emanating from Great Britain. There is also an undoubted lack of co-operation between finance and industry. Most countries lending abroad have some sort of agreement whereby the proceeds of a loan shall be spent on the manufactures of the lending country. This procedure is rarely followed in the case of British finance.

Competition from Other Countries.

Competition with Great Britain in the Japanese market, while keen from Japanese manufacturers in lines in which they have made good progress, is intensely keen from other industrial countries for such manufactured goods as Japan must or desires to import.

The United States.—The United States succeeds in Japan's trade because of—

(*a*) Her favourable position as the largest buyer of Japanese exports.

(*b*) Her financial interest in several of Japan's public utilities and industries.

(*c*) As a consequence of (*b*), the regular presence in Japan of American engineers and business men; and

(*d*) The fact that the United States has developed to a greater extent than any other country—certainly to a greater extent than Great Britain—the newer industries, such as the manufacture of motor cars, typewriters, refrigerators, &c., articles which are all in considerable and increasing demand in Japan.

The commercial intimacy of Japan and the United States is further strengthened by the latter's position as a supplier to Japan of raw cotton, wheat, timber, and oil. The large trade in these products causes constant commercial intercourse between the two countries and creates many common interests.

Germany.—The success which Germany has achieved as an exporter to Japan is perhaps even more remarkable than that of the United States, for Germany has no advantage arising from propinquity or from the supply of food or raw materials. Although German goods were eliminated from the Japan market during the war, Germany has regained her pre-war share of the Japanese imports of manufactured goods. As a supplier, she is practically on a level with Great Britain, whereas before the war her share was half the size of the British share. Germany's success is due to her ability to offer suitable goods at competitive prices, and to her energy and intelligence in studying the market and thereby achieving intimacy with it.

From the evidence we have seen, it is quite clear that Great Britain will be unable to hold even the reduced share of Japan's import trade which she now secures unless drastic reductions are made in the prices of British goods.

Distribution.

Representation of British Manufacturers.—Much of the decline of British exports to Japan is attributed in some quarters to the inefficiency of British merchant firms established in that country. Our trade to Japan in pre-war years was largely in the hands of the old-established import and export firms of British nationality. The number of these has diminished as the result of Japanese competition, and of the financial difficulties experienced during the war and after the earthquake of 1923. We have received a number of criticisms of British merchants in Japan. Some firms are alleged to possess rather liberal ideas as regards home leave and working hours. It is stated that continental firms work harder than British firms, and that their managers and staffs cultivate friendships with the Japanese, learn the language, and interest themselves in the affairs of the country to a far greater extent than the managers and staffs of British firms are accustomed to do. The result, it is affirmed, is that the business of British merchant firms, and consequently that of the British manufacturers whom they represent, does not develop owing to their lack of enterprise and hard work, and their failure to obtain new customers.

The merchant's answer to the criticisms directed against him is that, though British by tradition and sympathy, he is unable to sell British goods, principally because of their high price. He points out that the manufacturers of countries competing with Great Britain seek and use his services. He would undoubtedly prefer to continue his former trade in British goods, but his first duty, he claims, is to maintain his own business. He is therefore forced to sell the goods of our competitors when they are either more suitable or more attractive in price.

Complaints such as those referred to above, are so frequently made that we fear there must be some foundation for them, though we can personally testify to the existence in Japan of some British merchant houses which are second to none in energy and intelligence. It is, however, clear to us that, generally speaking, the distribution of British goods in Japan is lacking in intelligent direction, inspiration, and enthusiasm. The British merchant in Japan naturally deals in the goods which are most remunerative, and easiest to handle, and does not as a rule act as a pioneer for British manufacturers. The lesson to be learned seems to be quite clear. *The British manufacturer himself must provide the stimulus for the sale of goods in Japan, and indeed in all markets.* He must, without any doubt, lower production costs at home. Abroad he can strengthen his distributive machinery by one of three methods:—

(*a*) Attaching, at his own expense, one or more technical and sales promotion experts to an efficient merchant house in Japan;

(*b*) Undertaking the sale and distribution himself through his own branch establishment;

(*c*) Employing a resident agent working on commission.

Which of the three methods should be adopted, depends to some extent on the character of the product, but no matter what the product may be, method (*a*) or (*b*) will enable the British manufacturer to know for a certainty what the market requires and in what form to pioneer, seek out, and develop untouched portions of the market, to anticipate future needs, to create new demands, and to co-operate in local developments involving a demand for goods or equipment such as Great Britain can supply. It may be objected by individual British manufacturers that the volume of business would not repay them for the expense involved. The answer to this objection is to pool the distribution or export interest of a number of allied but non-competitive manufacturers, or to adopt method (*c*), which does not involve any immediate outlay by the manufacturer.

Whatever method is adopted, a personal visit of the principal of the home firm is indispensable to ensure that the right *personnel* is employed and the right methods are used. Complaints were often made to us that principals of British firms either do not visit the market, or when they do, spend an entirely inadequate time in Japan, often limiting their visits to a few days. Further complaints were made that very few British firms or industries maintain technical expert representatives in Japan. With this is contrasted the practice of the United States firms which have many more technical representatives than British firms, either attached to merchant houses in Japan or working independently and representing the interests, in some cases, of groups of manufacturers. As the United States and Japan have so large a mutual trade between them, there is naturally a constant going and coming of business men between the two countries, and the commercial intercourse thus promoted is a most important factor in developing transactions in many commodities.

But, we repeat, the stimulus for sales must come from the British manufacturer. He has, or should have, an interest much greater than anyone else in the sale of his goods, and the next main interest is that of the consumer. Whatever distributive organisation is necessary between these two must be efficient and free from the indifference to British goods which undoubtedly at present exists in some merchant firms. How can British manufacturers expect to enter or remain in a market in which they have no efficient distributive or informative organisation? By developing personal representation, British manufacturers should be able to gain and maintain complete intimacy with the Japanese import market, and, equally important, follow the development of Japanese industry in so far as it becomes competitive with them in other markets.

British trade has been handicapped by a manufacturing policy not fully cognisant of the requirements of overseas markets. Too often the British manufacturer relinquishes all interest in his goods when they leave the factory. Often, where the goods themselves are suitable, the packing or presentation is unattractive or inappropriate to a particular market. These are handicaps additional to those of high price and bad representation which we have discussed above. In addition, there is too often inattention to suggestions and complaints of overseas representatives. British manufacturers must realise that, in the world of to-day, as compared with the period of our virtual monopoly of trade, our competitors are not only watching for every opportunity of supplanting us, but are studying with far keener intimacy than we are, the needs, desires, and productive and consumptive capacity of the world's markets. If the British manufacturer took a greater personal interest in the distribution and use of his goods, he would, with the co-operation of an intelligent and industrious overseas staff, be in a far better position to compete with the manufacturers of other nations in anticipating the needs of the world, and in catering for them.

In the promotion of an aggressive sales policy for British goods abroad, the State has a duty to the home manufacturer, and this aspect of the matter will be dealt with later.

Publicity and Catalogues.—From the evidence we have received, there appears to be no doubt that publicity for British goods and achievements is far behind the needs of the time. Indeed, lack of advertising of British goods and the frequent publicity of failure in Great Britain—unemployment, the "dole," strikes, &c.—are the prevailing notes, with consequent discouragement of British merchants abroad, and loss of credit with old and prospective customers. National publicity is a subject which involves financial and political considerations, but we are of opinion that more publicity of British achievement and less of British failure would be of undoubted advantage, and would act as a stimulus to British welfare abroad. We commend the subject to His Majesty's Government for their careful consideration.

(To be continued.)

GENERATION OF ELECTRICITY.

As the outcome of the publication of their monthly statements showing the number of units of electricity generated by authorised undertakers in Great Britain, the Electricity Commissioners have been asked whether monthly or quarterly particulars for the years preceding 1928 could be made available for comparative purposes.

Figures on a quarterly basis for the years 1924 to 1927 have been prepared and are embodied in the table below, together with a summary, on a quarterly basis, of the figures already published for the years 1928 to 1930.

Quarter.	Units generated by authorised undertakers, approximate figures (M = millions).							
	1924	1925	1926	1927	1928	1929	1930	1931
	M.	M.	M.	M.	M.	M.	M.	M.
Jan.–March	1664	1798	1992	2209	2472	2844	3031	3185
April–June	1347	1430	1459	1760	1994	2254	2390	849
July–Sept.	1331	1453	1458	1814	1929	2193	2341	Ap'l only
Oct.–Dec.	1752	1984	2131	2460	2678	3003	3152	
Year	6094	6665	7040	8234	9073	10,294	10,914	

It will be noted that in each of the years subsequent to 1924 the output—units generated—in every quarter showed an increase over the output in the corresponding quarter of the preceding year.

The particulars given above are inclusive of certain cases in which stations belonging to companies other than authorised undertakers are leased to or operated by company undertakers and utilised for the purpose of their undertakings.

The sum of the quarterly figures, based on monthly returns, shows a slight variation from the finally revised annual figures subsequently published.

Railway and Road Matters.

THE summer train services are to be brought into use on July 20th this year. That is a fortnight later than usual.

WATER troughs are being laid down between Knebworth and Hitchin, on the London and North-Eastern Railway.

AN all-Pullman train is to be run in each direction between London and Bournemouth by the Southern Railway in that company's summer train service. It will call at Southampton West.

As was anticipated in this column of our issue of April 17th, the electrical services between London-road Station, Manchester, and Altrincham, on the Manchester South Junction and Altrincham Railway, were brought into use on Monday last, May 11th. They are described elsewhere in this issue.

THE reconstruction of the stations at Great Portland-street and Euston-square, Metropolitan Railway, to allow for the extension of the platforms, which is, we believe, to be followed by the lengthening of those at King's Cross, Farringdon-street, and Aldersgate, is being assisted by Government grants from the Development (Public Utility) Advisory Committee. It is not expected that the whole will be completed before February, 1933.

THE new secretary to the Institution of Locomotive Engineers in place of the late Mr. Joseph C. Sykes is Major Hubert A. Harrison, who entered upon his duties on May 1st. Major Harrison became a premium apprentice at Crewe in 1897 and in 1912 left the London and North-Western Railway to go to the Antofagasta (Chile) and Bolivia Railway, on which he became locomotive superintendent. In 1916 he received a commission in the Royal Engineers and since 1922 has been with private firms.

A USEFUL night down train from London to the West of England and a corresponding up train will be provided by the Great Western in its summer services. The former will leave Paddington at 1.40 a.m., call at Taunton, Exeter, and Newton Abbot, and reach Plymouth at 6.5 in time to form the 6.12 a.m., Plymouth to Penzance. The up train will actually be the 6.20 p.m., Plymouth to Paddington, which will travel *vid* Westbury instead of through Bristol and be due at Paddington at 11.20 p.m., in place of 2.40 a.m. A connection to Bristol will be given from Taunton.

INVESTIGATION by experts show that the fire on April 29th in an Egyptian State Railways train, by which forty-six lives were lost—many through jumping from the burning coaches—was not due to any mechanical defect, but must have been caused by some action of a passenger. Photographs now to hand show that the vehicles were equipped with the vacuum brake and thus the question at once arises as to why there was not passenger communication. Had that been so the pulling of the alarm chain by a passenger would have made an automatic application of the brake.

THE railways of New Zealand are owned and operated by the State. There have been changes in the form of administration; railway commissioners, ministers of railways, general managers, &c., have been tried, and now there is to be a railway board of three persons, who are not to be members of Parliament, nor railway servants nor concerned in any rival transport organisation. The board is to have all the powers now exercised by the present general manager and the Minister of Railways. The general manager is to be appointed by the Governor-General, on the recommendation of the board.

IN view of the opposition of railway companies to the issue of licences for road transport services, it would seem desirable to point out that the Road Traffic Act appears to call for such opposition. Section 72 says that the Area Commissioners shall, for instance, have regard to the extent, if any, to which the proposed routes or any of them are already adequately served and the extent to which the proposed service is necessary or desirable in the public interest. Moreover, there must be considered the needs of the area as a whole and the co-ordination of all forms of passenger transport, "including transport by rail."

ANSWERING a question on May 6th as to the street traffic signals in Oxford-street, Mr. Morrison said that he hoped that they would be in operation by the end of June. The signalling apparatus—as distinct from poles, cables, &c.—was to be of foreign manufacture, because, when the question of controlling traffic in that way in Oxford-street was first investigated, no British firms were manufacturing or had any experience of the type of signals required. He was glad to say that in that respect the position had improved, and in connection with future installations importance was attached to encouragement of British manufacture so far as possible.

THE Ministry of Transport railway statistics for February have recently been issued as a Stationery Office publication, price 2s. 6d. They show that the number of passenger journeys, when compared with February, 1930, decreased by 5·9 per cent., and the receipts from passengers by 7·9 per cent., but the passenger train mileage was reduced by only 1·0 per cent. The goods tonnage suffered the big drop of 17·7 per cent. and the goods receipts of 12·6 per cent. Goods train mileage was, however, lowered by 8·0 per cent. The average train load decreased from 133½ to 126½ tons; yet, despite lighter loading and less traffic, the trains moved more slowly, as the net ton-miles per engine-hour fell from 451½ to 445¾.

THE *Railway Review*, though, in common with the Press generally, high in its praise of the report of the Main Line Electrification Committee, is nervous as to the effect of the wholesale conversion from steam operation to electric traction. It speaks of the cleaning and maintenance services being considerably reduced and the number of tractors lessened by 30 per cent.; above all, of one motorman alone instead of two enginemen. Our contemporary proceeds to say: "The unions (the National Union of Railwaymen and the Associated Society of Locomotive Engineers and Firemen) will have to act jointly in this important matter, and it may be that the circumstances we shall be called upon to face will serve the dual purpose of bringing a nationalised system of transport and a national transport union into being."

Notes and Memoranda.

IT is said that the preservation of railway sleepers in Italy is now effected entirely by the all-creosote vacuum process, the utilisation of a mixture of zinc chloride and creosote having been abandoned.

IN a booklet just published by Gabriel, Wade and English, Ltd., of Aldwych House, London, W.C. 2, there is some useful information as to the qualities of the principal soft woods exported from British Columbia, together with some excellently illustrated descriptions of the trees and timbers.

A CHEMICAL discovery of great interest is reported in the *Chemical Trade Journal* to have been made by Dr. H. W. Thompson, of Oxford. When oxygen and hydrogen sulphide are mixed in certain proportions and under certain conditions, they explode. Dr. Thompson finds that they explode, not once only, but continue to explode at intervals of a minute or so, like a Chinese cracker. The mechanism of this reaction is not yet understood.

SEVERAL years' research on the production of desirable lubricating oils from paraffin-base crude has, says *Power*, led to the adoption of the Edeleanu process by the Bayonne refinery of the Tide Water Oil Company. This process is based upon the selective solvent action of pure liquid sulphur dioxide, which has the property of completely dissolving those compounds in petroleum distillates that are most susceptible to decomposition and oxidation in service. The paraffin and naphthene hydrocarbons are insoluble in the solvent at low temperatures. The removal of the easily oxidised and sludge-forming compounds makes Edeleanu-treated oils especially desirable for lubricating high-speed turbines and engines, where conditions conducive to rapid oxidation usually prevail.

IN the Artillery Museum of Stockholm there is an ancient mirror of large dimensions, formerly used by the Swedish army as a means of defence against hostile ships approaching Sweden's shores. The mirror, it is said, was placed in the sun and thus used to set fire to the vessels at sea. An interesting scientific adaptation of the burning mirror has now been made by two Swedish scientists, who have constructed a melting furnace for scientific purposes by using an elliptical mirror and an electric arc lamp as a source of heat, instead of the sun. During a recent demonstration of the furnace before the Society of Physical Research, the inventors obtained a temperature high enough to melt a metal with a melting point of about 2100 deg. Cent. At another test the mirror was focussed on a piece of platinum, which, in four minutes, was melted and brought to boil like a liquid.

ACCORDING to Mr. Andrew Stewart, of the Manitoba Agricultural College, a tractor operator with a five-bottom 14in. plough can turn over more land in one hour than the same man with a walking plough could cover in a day. Ten days of one man's time are required with a one-horse outfit to cultivate the same acreage that the four-row outfit can cultivate in one day. In 1830, with hand production methods, thirty-two hours of man labour were required to produce 10 bushels of wheat. In Montana an acre of land has been summer fallowed and a crop of wheat removed the following year with 2·5 hours of man labour. Modern machinery has reduced the labour of husking and cribbing corn twenty to thirty hours per acre. The labour in 1 ton of hay in bales was reduced between 1860 and 1894 from 35½ hours to 11½ hours. This reduction in labour has resulted in a large acreage operated per worker. Since 1850 the average acres of improved land per worker in the United States has increased steadily from 30 acres to 49 acres in 1925, and the figures for Canada show that between 1881 and 1891 acres of farm land per worker increased 95 per cent., improved land per worker 105 per cent., and crop acres per worker 109 per cent.

AN important effect of machinery in agriculture, mentioned in the prize essay of the Royal Bank of Canada Economics Fellowship, has been the reduction of the proportion of total population engaged in that industry. This has been evident both in the United States and in Canada. In 1820 the United States Census reported about 88 per cent. of all gainfully employed persons as engaged in agriculture; by 1850 the percentage had decreased to 80 per cent.; by 1870 to 47·6 per cent., by 1900 to 35·7 per cent. and by 1920 scarcely 25 per cent. were so reported. Dr. Erdman points out two interesting phenomena which arose in spite of this marked reduction in the percentage of the nation's workers employed in agriculture: first, a growing complaint about an over-production of agricultural produce; and second—a tribute to the inconsistency of our thinking—a lot of discussion about the danger which faced the nation because farmers were leaving their jobs. In Canada the percentage of the population engaged in agriculture has steadily declined. The figures are:—1881, 48·1 per cent.; 1891, 45·8 per cent.; 1901, 40·2 per cent.; 1911, 34·3 per cent.; 1921, 32·8 per cent. During this period the surplus of agricultural exports over imports increased 600 per cent.

GROUP piecework is the term applied in America when the activities of two or more employees are combined in building up a common unit or group of units, in which each employee shares in the resulting earnings in proportion to his hourly rate and the number of hours that he works. The system has proved particularly successful in the motor car, electrical, radio, accounting machine, and similar industries, although it has even been successfully applied to office work. In situations capable of being adapted to the conveyor system the group method is claimed to be indisputably superior to any other. The Metropolitan Life Insurance Company of New York recently made a survey of the whole situation, which describes in detail the methods used by such companies as the National Cash Register Company, Western Electric Company, Westinghouse Electric and Manufacturing Company, Packard Motor Car Company, Edison Electric Appliance Company, and various others. Methods of payment to group pieceworkers vary widely in the different industries, and it is of great interest to see how each company solved the particular problems which confronted its workers. We understand that interested employers may secure a copy of this report by applying to the office of the Metropolitan Life in Bush House, Aldwych, London, W.C. 2.

Miscellanea.

A NEW direct telephone connection between London and Oslo has been put in service.

IT is proposed to install a floating dock at North Vancouver for ferry landing purposes. The estimated cost is 55,000 dollars.

IT is proposed to utilise the water power of the Imatra Falls in Finland for the fixation of atmospheric nitrogen to the extent of 50,000 tons a year.

A COPPER rod rolling mill, with a capacity of 15 tons of ½in. rod per hour, is being put down by the Phillips Electrical Works, at Brockville, Ontario.

OFFICIAL statistics show that if the present rate of increase in the number of telephones is maintained, there will be 2,000,000 telephones in this country by the end of May.

IT is announced that Senator Marconi and Professor Lombardi will represent Italy at the centenary celebrations of the discovery of magneto-electrical induction by Michael Faraday in 1831.

A FACTORY for the manufacture of formaldehyde is being put up at Maccagno, Italy. Its capacity will be from 5 to 6 tons of 40 per cent. solution a day, which is more than the present requirements of the whole of Italy.

IN conformity with its policy of developing the country's mineral resources, the Chinese Ministry of Industries has decided to despatch mining experts to investigate the extent of iron deposits in the north-east and north-west. The deputies will first proceed to Jehol and later to Liaoning, Kirin, and Heilungkiang to conduct surveys. A party of seven engineers has left the capital to engage in surveys during the next six months.

A PLANT for the manufacture of synthetic acetic acid, and with a productive capacity of 250 tons a month, is, says the *Chemical Trade Journal*, being erected by the Societa Italiana Prodotti Sintetici. The raw material will be calcium carbide, the acetylene produced being converted into acetaldehyde, and then into acetic acid, by the usual method. Part of the output of the firm will be sold in the form of anhydrous sodium acetate.

THE natural gas output in Canada set up a new high record in 1930 when 29,104,570 thousand cubic feet were produced. Wells in Alberta accounted for more than 70 per cent. of the total production. Increasing quantities of natural gas are being produced from the wet gas field of the Turner Valley field, Alberta, and the problem of utilising all this gas continues to be the subject of much study. Experimental work was done during the year in connection with the storage of some of this gas in the exhausted sands of the Bow Island field.

THE Department of Overseas Trade announces that Mr. R. Boulter, C.M.G., H.M. Trade Commissioner at Singapore, will shortly be in London on an official visit. Mr. Boulter will be available at the offices of the Department during the period June 1st to 12th to interview manufacturers and merchants interested in the export of British goods to British Malaya. Firms desiring interviews with Mr. Boulter at the Department should apply to the Comptroller-General, Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1, quoting reference 2861/1/31.

Two mail and passenger ships of 14,000 tons, each equipped with an aeroplane-landing stage, are among the vessels now under construction in Spain, according to the report just issued by the Spanish Naval Construction Board. The aeroplanes carried by these ships will be used to facilitate the movement of the mails. Among other activities of the Board, which has dockyards and factories in many parts of Spain, is the construction of two warships to replace those recently ceded to the Argentine Government, while two other vessels are being constructed for Uruguay. The contract for these was obtained in an international competition. The Board has also constructed a tank over 100 yards long, in which to test models and a laboratory where artificial waves are produced to carry out tests on vessels.

A SPECIAL "lightning" service for speeding-up cablegrams between London and important centres in Argentine and Brazil has been introduced by Imperial and International Communications, Ltd., in conjunction with its associated company in South America, the Western Telegraph Company. By means of this service, which involves no extra expense, telegrams can, for example, be sent from a house in Buenos Aires and delivered to another in London in from 1 min. to 1½ min. Thus a message telephoned from an office in the Argentine capital to the cable company's station there is transmitted directly to the headquarters station in London. Immediately the name of the addressee is signalled at the receiving end in London, warning is given to a waiting telephonist who secures a line to the firm or individual concerned. The completed telegram is then sent over the telephone and a confirmatory message in the usual sealed enveloped sent on by hand later. Similar arrangements have now been made to speed up the services to South Africa and Singapore.

THE Council of the Institution of Electrical Engineers has established the Silvanus Thompson Scholarship, the first award of which will be made this year. This scholarship is for works employees, and is of the value of £100 per annum and tuition fees, tenable for two years. Each candidate must be nominated—not later than June 15th, 1931—by a corporate member of the Institution, and must be the son of parents of limited means. The award is open to British subjects under twenty-two years of age on July 1st, 1931, who (*a*) have served a minimum apprenticeship or its equivalent of three years at an approved electrical engineering works, and (*b*) in addition to having taken full advantage of available opportunities for technical education, have acquired a marked degree of skill, and/or shown evidence of originality. The successful candidate will be required to take up a whole-time day course in electrical engineering at an approved university or technical college. The second awards of the following scholarships will also be made this year:—The Duddell Scholarship, which is of the annual value of £150, and is tenable for three years; and the Ferranti Scholarship, of the annual value of £250, and tenable for two years.

MANCHESTER-ALTRINCHAM RAILWAY—SUB-STATION EQUIPMENT

THE BRITISH THOMSON-HOUSTON COMPANY, LTD., RUGBY, ENGINEERS

(*For description see page 536.*)

FIG. 6—MERCURY ARC RECTIFIER, OLD TRAFFORD

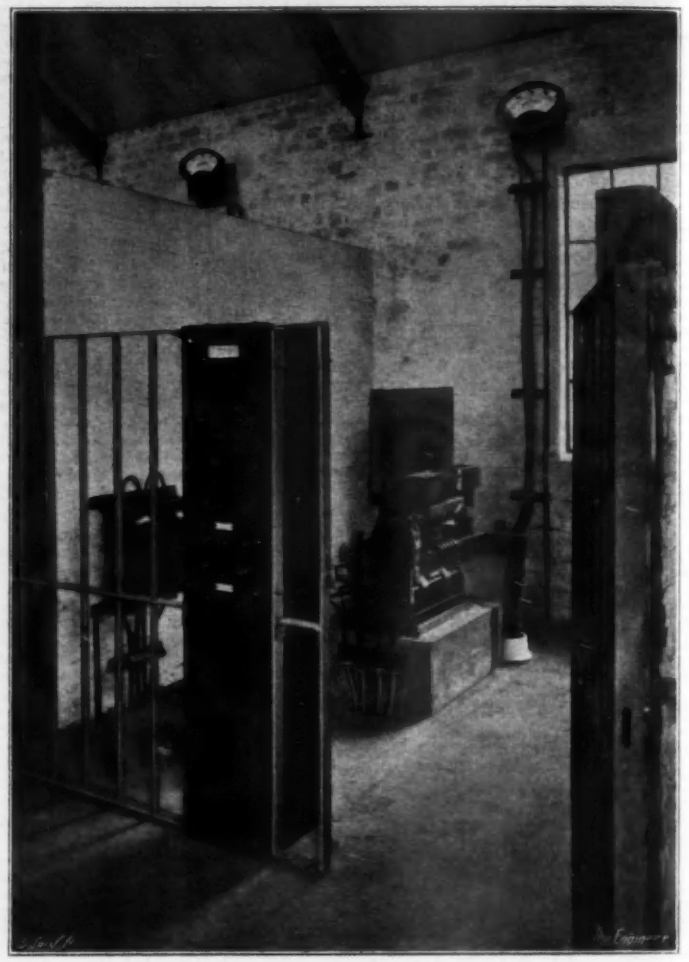


FIG. 7—TRACK FEEDER CIRCUIT BREAKER, OLD TRAFFORD

FIG. 8—ROTARY CONVERTER, TRANSFORMERS, ETC., TIMPERLEY

FIG. 9—REMOTE CONTROL PANEL, OLD TRAFFORD

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THE ENGINEER.

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MAY 15, 1931.

Corrosion.

SOME years ago Sir Robert Hadfield estimated that the total sum spent annually in counteracting the ravages of corrosion was in the neighbourhood of five hundred million pounds per annum. In America it is believed that as much as 20,000,000 tons of steel are destroyed by rust and have to be replaced every year. These figures are astounding, but at least they explain why it is that ever since man emerged from the Stone Age efforts have been made to discover some means of preventing the destruction of metals in this way. Since the mechanical revolution of the last century and the consequent enormous increase in the use of steel and iron, such efforts have been redoubled, and in recent years several Institutions and Societies have appointed committees to study the problem, and many private firms and individuals have themselves conducted researches. In the majority of these cases attention has been directed only to one aspect of the subject. For instance, in 1921 the Institution of Civil Engineers set up a Committee to study the corrosion of steel in sea water; and in 1911 the Institute of Metals appointed a Corrosion Research Committee which confined itself principally to condenser tubes. But three years ago, the Iron and Steel Institute, in conjunction with the National Federation of Iron and Steel Manufacturers, appointed a committee to study the whole subject as far, at least, as ferrous metals are concerned.

On another page of this issue we publish the second part of a summary of the first report of this Iron and Steel Corrosion Committee, from which it will be seen that full advantage is being taken of the opportunity presented by the wide terms of reference to correlate properly all the knowledge so far collected, and to bring it down, so far as that is possible, to a common basis. In pursuance of this intention, the Committee set about preparing standard conditions for making tests of corrosion, and, were it to do nothing of greater value, that alone would make it memorable. In fact, the Committee has come to the conclusion that insufficient evidence exists to warrant the exclusion of the examination of any detail of the manufacturing processes through which the test pieces pass; of the means, whether by paint or otherwise, by which they are protected; or of the atmospheric conditions to which they are finally exposed. Very full records are therefore being kept. In addition, a questionnaire was sent out to many firms and companies likely to be interested in the subject, and the replies received lead to some interesting reflections. On the whole, it appears that the lasting qualities of steel and iron are quite satisfactory for structural purposes so long as sufficient surface protection is afforded to the metal. Many of the replies pointed out that in most cases a structure is not replaced because the ravages of corrosion have made it unsafe, but because either it has become obsolete or the needs of the moment demand properties which it does not possess. Generalising, therefore, and specifically excluding all parts, such as turbine blading, boiler tubes, and the like, which the Committee has not yet had time to investigate, it may be said that the longevity of steel and iron, if adequately protected, is sufficient for its purpose. It would seem, then, at first that no advantage accrues from attempting to reduce the corrodibility of such structures. But protection is exceedingly costly—there's the rub. The Forth Bridge, weighing roughly 51,000 tons, costs annually for painting and repairing something in the neighbourhood of £10,000—the actual figure for last year being £8983. Thus a reduction of the cost of protection, either by the discovery of a better paint or other coating or a reduction of the susceptibility to corrosion of the metal, even at a greater first cost, would be highly advantageous. It will be seen from the figure we have given that in the case of the Forth Bridge, an increase of first cost to the extent of as much as a quarter of a million pounds would have been profitable if permanent protection could have been assured. The actual cost of the bridge was about £3,100,000. If we put the present value of that sum at, say, £4,000,000, that would mean that it would be worth while to expend about one-eighth more upon construction if a non-corrodible material could be found.

Of the two ways by which the subject can be approached, research into the efficacy of paints is outside the scope of the Committee. Indeed, that body has restricted itself only to two paints, the better to correlate its researches on surfaces protected in that way. But as far as corrosion proper is concerned, it has been given the widest of fields in which to work. Item 4 in its terms of reference reads: "Any other matters, relevant." It is therefore almost unrestricted and can investigate any phenomena or any processes which it may believe to have effects upon corrosion. If the problem, how best to combat the ravages of corrosion, is ever to be solved—and we believe that, except for certain isolated and special conditions, it is most unlikely that any general solution ever will be found—this Committee has a better chance than any body of men selected before to carry out such a search, and to find a satisfactory answer. Never before perhaps has the problem been attacked with so much determination and on so large a scale, and both the Institute and the Federation, and their Committee are to be congratulated, the former for providing the other with terms of reference wide enough to cover any possible contingency, and the latter for the energy and clear thought it is bringing to bear upon the subject.

The Progress of Power Production.

JUDGING from the manner in which Mr. W. B. Woodhouse's May lecture on "The Progress of Power Production" was received at the meeting of the Institute of Metals held on Wednesday of last week, the members of that body are keenly interested in power problems. So much has been said at electrical engineering gatherings and written in engineering publications about electric power, that it is difficult for any expert to impart new knowledge to those engaged in the electricity supply business, but those who are not so closely connected with electrical engineering are naturally not so well informed and are ready to listen to a recognised authority on electrical matters. It is desirable that people associated with important industries, and particularly those who use or contemplate using electricity on a large scale, should know something about past progress and what prospects there are of cheaper supplies in the future. Larger machines, greater efficiency and, relatively speaking, lower first cost, Mr. Woodhouse explained, had all helped to reduce the price of a unit to a figure undreamt of thirty years ago, but in no way regarded as final to-day. Progress in the

electricity supply business has certainly been remarkable, but, on Mr. Woodhouse's own showing, the limit to what can be done in the way of cheapening generation with existing methods is now being reached. No one who knows anything about the generation of electricity imagines that the efficiency of the most modern stations is going to be greatly improved; indeed, even if it were cheap electricity would not be made available for all purposes. By all means let engineers strive to obtain the best possible thermal efficiency and thereby save coal, but let no one suppose that their efforts will result in a vast benefit to all consumers.

The existing method of generating electricity may produce a unit with less than 1 lb. of coal, and on the basis of coal at 10s. a ton, the fuel cost at the power station would be only one-twentieth of a penny, or, say, 30s. per kilowatt-year of 7000 hours. Although individual turbines are developing a kilowatt-hour for less than 10,000 B.Th.U., it may be taken that even in the most modern stations a unit is at present produced with a heat consumption of 14,900 B.Th.U's, or about 1·25 lb. of slack coal; but, needless to say, even this figure has not been generally attained. The last published statistics of the electricity supply industry showed that in 1929 the average consumption by all generating stations in the country was 2 lb. of coal per unit, so that, quite apart from any further improvement in the thermal efficiency of the most modern stations, a large amount of coal can be saved by improvement of existing stations. If the cost of coal mainly determined the cost of electricity, even with the present method of generation, all consumers might be satisfied. Unfortunately, however, the cost of distribution to small users whose demands are only intermittent—as in the case of the user of electric light—adds greatly to the final cost, and any possible improvement in generation can have little effect on the cost of supplying these consumers. Even now, it cannot be emphasised too strongly that when experts quote exceptionally low prices for electricity they refer to special conditions and not to consumers as a whole. It is well known that there are many hours a day, and many days in the year, in which the demand upon central stations falls below the maximum for which generating plant has been provided, and if a user can be found to take current during those hours the cost of supplying him is only the increment due to generation alone. Large users of electricity in the vicinity of modern generating stations, and particularly those who can take their supplies at "off peak" periods, may find that the prices are satisfactory. Others may find, however, that in spite of all modern improvements in generation and the establishment of the "grid," the price is too high. Only a few weeks ago, Mr. Borlase Matthews was complaining about the prices charged for bulk supplies and the matter was also referred to by Dr. Ekstroem, during the discussion on the recent paper read before the Institution of Electrical Engineers on "Electric Heating." How much these prices can be reduced by further improvements in generation and by interconnection remains to be seen. The application of electricity to metallurgical and chemical processes, Mr. Woodhouse explained, gave real hope of progress, but much would seem to depend on where the consumer happens to be situated and on his ability to take his supply during certain hours.

According to Mr. Woodhouse, all developments point to the consumption of fuel at generating stations of increasing size in a manner determined by the requirements of efficient power production, rather than by considerations such as those pertaining to the use of waste heat from other processes. The utilisation of waste heat from processes such as the production of iron and coke, he contended, presented little prospect of extension, because the line of development was in the direction of reducing the surplus of heat from such processes. It seemed fundamentally uneconomic that an apparatus such as a blast-furnace, which required three times as much coke as was necessary for smelting should continue to be used, and the development of alternative methods could not be long delayed. But, just as the blast-furnace wastes heat, so does the electric generating station, and it seems reasonable to suppose that some day the present method of producing electricity will also give place to a less wasteful method. What the future holds in store no one can tell. At present use is being made of what are believed to be the best methods of generation and supply. As Mr. Woodhouse showed, however, the need for widespread interconnection is, perhaps, less in Great Britain than in any other industrial country, for the industrial areas are all in the neighbourhood of coalfields, or of the coast, and the amount of water power is, relatively speaking, negligible. The British scheme is based on the assumption that the savings in generating costs will outweigh the burden of capital charges and operating expenses of the "grid," and its measure of success will be the reduction of the price paid for electricity by the distributing authorities. Much will, of course, depend on the rate at which the use of electricity increases, and the electrification of the main line railways of this country would, no doubt, be a decided help to those who are entrusted with the difficult task of making the "grid" pay.

Literature.

Principles of Engineering Thermodynamics. By Professor Paul J. Kiefer and Professor Milton C. Stuart. London: Chapman and Hall. Price 22s. 6d.

It has been said that American technical books can only be divided into two classes—the really good and the definitely bad. How far such a statement may be justified we need not discuss; but it is certainly convenient in the present instance as it leaves no room for doubt into which category the volume of Professors Kiefer and Stuart must be placed. They have produced a well-written, logical and systematic presentation of a somewhat difficult subject, and have spared no pains to make its principles clear. Commencing with the elementary conception of energy in its various forms, the student is led up to the general equations in which our knowledge of the thermodynamic properties of substances is embodied, learning, on his way, the application of the science to the various problems of the engineer. Practical requirements are kept in the foreground throughout, and whether the reader is interested in steam plant, internal combustion engines, compressing or refrigerating machinery, he will find the underlying principles of operation well set out. The book, indeed, covers more ground than the usual treatise on thermodynamics, for it includes a chapter explaining the calculations required in connection with the combustion of fuel, another on gas and vapour mixtures, together with adequate consideration of the phenomena of super-cooling and the like.

A chapter which we would particularly commend is that dealing with entropy. This "ghostly quantity," as Perry called it, has long been a source of trouble to students. Those who were mathematically inclined have been too apt to regard entropy merely as a combination of symbols, which, handled in an appropriate way, led to the production of more symbols with a nearer approach to intelligibility. Others, and, possibly, the majority, have been content to know entropy only as a number to be found in steam tables, extremely convenient for certain calculations, but conveying no more physical idea than a logarithm. In both cases the function is a useful one, as it meets the particular requirements of those who employ it, but in neither can it provide much intellectual satisfaction. Swinburne pointed out, years ago, that entropy, reckoned from any arbitrary zero of temperature, was really a measure of the change of the unavailable energy in a pound of fluid, when the latter passes from one state to another. With every temperature change that can take place by itself in Nature, the energy available for further work is decreased, although, according to the law of the conservation of energy, there must remain as much total energy in the system as before. The increasing unavailability of the heat energy of a system is measured by the increase of its entropy, but this fundamental conception of what entropy really means has been far too much lost sight of. The authors, however, have restored it to its rightful place, leading easily up to it from the principle of Carnot, and have, consequently, given the student a better physical grasp of the subject than could be obtained from any text-book we can think of. "The concept of entropy as an index of unavailability, is," as they emphasise, "one that is both invariably valid and pre-eminently significant."

All numerical data throughout the book are given in British units and Fahrenheit temperatures. The word "pound" is used, in the way engineers use it, both as a unit of mass and of force, and without any of the confusion which some writers have created in a well-meaning attempt to avoid it, by inventing terms like "slug" and "poundal," which have never got beyond the walls of the class-room. The word "enthalpy" has been chosen to signify the function (E+A P V), usually known as "total heat." Fortunately, however the authors have retained the symbol H, adapted by Callendar, to designate it, instead of the somewhat pedantic letter I, which has no alliterative value, in this sense. Most of the other symbols, happily, are also used with their familiar meanings, so that the reader has rarely to make the mental gymnastics imposed on him by some writers on the subject. The letter S, however is employed to designate entropy, but not in any endeavour to avoid the Greek alphabet, since the function (E−T S) is denoted by the Greek letter ψ—psi. It is stated in the preface that the symbols employed are, "in the main," those recently adopted by the American Standards Association, and for the convenience of the reader an explanatory list is given with each chapter. There is, therefore, as we have indicated, the minimum cause for complaint with regard to symbolism, and one can never read a book such as the present one without a regret that it cannot be made an international offence to exercise the individualism affected by certain authors in their choice of symbols for ordinary quantities or functions.

The chapter devoted to steam turbines is sufficient for a work of this kind, though it is to be hoped that the student will not take the sectional illustration of a reaction turbine as even remotely representing anything that is now constructed. He may be still further misled by a paragraph, which states that "turbines made up wholly of reaction elements are not much used," and that "the large modern turbine either is entirely of the impulse type, or it uses one or two Curtis stages at the high-pressure end, through which, perhaps, a half or more of the total steam pressure drop is caused to take place." The authors ought to have known that the pure reaction turbine leads, and has always led, the way in size. Even in their own country, the 25,000 kW Parsons machines supplied to the Fisk-street station in 1912, and the 50,000 kW set of the same make put to work a few years ago in the Crawford-avenue station, both established records for size at the time, and neither has a single impulse blade in its composition. An even later and larger example is the great 160,000 kW set recently installed in the Hell Gate station, which also is a pure reaction machine. Again, we are asked to believe that the use of reduction gears at sea, has weakened the position of the reaction turbine for marine propulsion, in favour of the impulse machine. Considering that the marine reduction gear was due entirely to the enterprise of Sir Charles Parsons himself, the view is improbable, to say the least, while the overwhelming preponderance of reaction turbines in gear-driven ships should be a sufficient answer to the contention of the authors. With a truer knowledge of modern practice the paragraphs in question could hardly have been written. They must not, however, be taken to condemn the book, which, apart from them, deserves very high praise. It is excellently printed, without, as far as we noticed, a single misprint, and can be cordially recommended to the class of readers for whom it is intended. The questions at the end of each chapter and the numerous arithmetical examples given in the text compel the student to realise that the study of thermodynamics has a real bearing on practical problems and that the knowledge to be gained from the book is worth acquiring for this reason alone, quite apart from the intellectual culture which it affords.

Land Drainage and Flood Protection. By Bernard A. Etcheverry, M. Am. Soc. C.E. London: McGraw-Hill Publishing Company, Ltd. 1931. Price 15s.

For many years the practice of land drainage in England, by traditional means and with the exercise of inherited skill, has been supplemented by works carried out and maintained under the supervision of authorities able to employ competent civil engineers. Not always have the measures taken been well conceived, and it really seems that some organisations for land drainage have been functioning without due appreciation of the laws of hydraulics or the details of soil and topography. Flood protection, on the other hand, has been almost entirely a matter of local, and therefore purely selfish, enterprises largely carried out without competent advisers and, while prejudicial to interests upstream and downstream, far from satisfactory in local effects. While engineers who have practised overseas often have the necessary qualifications, it seems that relatively few of those employed at home have really grasped the subjects of land drainage and flood protection.

A book on those subjects by the author of that excellent work "Irrigation Practice and Engineering," is therefore a welcome addition to the far from adequate information available in concise form and strictly relating to land drainage and flood protection. It will be appreciated by those engineers and teachers who realise that, as suggested above, further elucidation is needed in regard to the theory of hydraulics, details of soil and topography, and certain significant aspects of land drainage, which are frequently ignored. As regards hydraulics, the subject of the behaviour of water in the soil is well expounded in the earlier chapters, and duly considered elsewhere, while problems of flow in river channels are discussed with due regard to silt deposition, scour, and other aspects. Methods of computation of flow in open ditches are explained, in a scientific and practical manner, and the forms given to such channels are discussed. To quite as great an extent as can be expected, in a single work covering two subjects, topography in detail is presented, but less fully than the properties of soils, which the author has studied closely and describes at considerable length. Chiefly in respect of theories of contribution and of assessment, general policy is discussed in Chapter XIII.—not XII., as misprinted in the Preface—on Drainage and Reclama-

tion Districts; but there is no corresponding matter relating to the correlation of flood protection works, the importance of which organisation is perhaps less in most American countries than in Great Britain.

The less considered aspects of land drainage, which have received consideration in the book, include the relation of surface drainage to underdrainage, artificial drainage in its aspect as supplementary to natural drainage, and the drainage of lands waterlogged by irrigation, which, as the author points out, is of significance in respect of wet lands in humid climates. Local waterlogging, it may be observed, frequently develops as a result of building embankments, for canals, mill leats, railways, and other works. Notably, the measures referred to in the following quotation from Chapter VII., page 106, have been neglected in England: "When the surplus water [from adjacent higher lands] is surface run-off, it may be intercepted, collected, and conveyed by an open-drain ditch, placed on a falling contour grade, along the lower edge of the higher lands, skirting the area to be protected." Pages 106 and 107 are specially to be commended to the notice of our land draining engineers.

Having these useful features, the work is in other respects to be commended, as presenting the elements of the subject, their application to normal practice and special problems, with much useful detail relating to design and construction. As a work on flood protection it has considerable value, while in regard to land drainage it has a wider and deeper significance. A large amount of precise information and useful guidance is afforded in its 327 pages, while the 141 figures and numerous tables adequately support the text. A useful feature is the provision at the end of every chapter of a list of sources of information, the aid of which in preparing his book the author thus and otherwise acknowledges. This well-conceived and broadly based work may be commended as an aid to the teaching and practice of both the subjects of which it treats.

SHORT NOTICES.

Fuel Oils and their Applications. By H. V. Mitchell. London: Sir Isaac Pitman and Sons, Ltd. 1930. 5s.—The author states that his aim in this book has been to outline the principles involved in the selection, examination and the use of fuel oils for various power and heating purposes. He starts with cataloguing the oil resources of the world and goes on to the classification of the oils produced, with which he includes mineral spirits. There is a chapter on the examination of fuels and another on their calorific values, in which he discusses the relative merits of the "higher" and the "lower" calorific value. The remainder of the volume, which is of some 170 pages and is well produced, is devoted to descriptions of oil firing apparatus.

Gas Installations and Appliances. By A. T. Gilbert. London: Crosby Lockwood and Son. 1931. 8s. 6d.—A practical little book, evidently written by one who knows his subject—he once belonged to the South Metropolitan Gas Company—which should prove useful, not only to the gasfitter, but also to the architect and the householder. There is a proportion of theoretical matter in the text, but no more than is necessary to elucidate the practical side of the subject. There are also some historical references, which, although interesting, seem unnecessary. The subject matter includes the materials and fittings used by gas consumers, and in this connection the author suggests that the quality of gas cocks might be improved. There are some notes on gas burner development, gas lighting, cooking, house and water heating, and the maintenance and inspection of appliances. The book comprises some 300 pages, is well printed, and adequately illustrated.

Punches, Dies and Tools. By Joseph V. Woodworth. Fourth edition. London: Crosby Lockwood. 18s.—This is essentially a book for the practical man and its usefulness is demonstrated by the fact that this is a fourth edition. It does not deal with the fundamental principles of construction at all, but is intended to detail as exhaustively as possible the numerous methods of procedure for the construction of punches, dies, and tools, and the form they should take for the best work. As an encyclopædia of all that is at present known about the subject it could hardly be bettered. In spite of the large amount of material contained within its covers, and the fact that it runs to 538 pages, the book is of the useful size that can, if necessary, be slipped into an overcoat pocket.

Ausgewählte Schweisskonstructionen: Vol. 2, *Maschinenbau.* By Dr.-Ing. Karl Haas. Berlin: V.D.I. Verlag G.m.b.H., Berlin, N.W. 7. 1931. Price 14·50 marks.—This book is the second volume describing and illustrating a number of chosen examples of welded construction, some ninety-seven in all, which have been collected and published by the V.D.I. Committee for Technical Welding and the German Electric Welding Committee. As in the previous volume, which dealt with welding as applied to structures, the examples are well illustrated by drawings and photographs in such a manner that the reader can follow the way in which the part has been assembled and welded without having an extensive knowledge of technical German. The pages of the book are bound in a special loose-leaf form, so that individual leaves can be taken out and new examples can be conveniently added. The subjects dealt with include the design of various small brackets and supporting pieces, such as are usually made in a cast form, and the welding of drills, lathe tools, and tool-boxes. Crank shafts and gear cases having been dealt with, an excellent series of examples of welding applied to machine tools, generating plant, engine seatings, turbines, cranes, and transporting machinery are given in the following pages. Most of these, we note, are taken from the practice of representative American and German firms. Each example is accompanied by a short descriptive note, and in certain cases a further detailed drawing is introduced. The volume referred to will shortly be followed by others of the series dealing with welding in its application to shipbuilding, to tanks and to pipe systems. We have no hesitation in warmly recommending this series of handbooks to all who wish to study modern welding practice applied to engineering design and construction.

Waterworks for Urban and Rural Districts. By Henry C. Adams. Second edition. London: Sir Isaac Pitman. 15s.—The first edition of this book was published in 1922, but in this second edition it has not been considered necessary to make any material alterations. A little of the matter contained in the first has been omitted, and new matter which takes notice of modern improvements has been added. While not entering very deeply into theory or practice, the book covers the elements of the subject very well, and includes formulæ, references, and methods in general use. It is hoped, therefore, that it will be found useful as a guide and source of reference to all interested in the subject. It includes chapters on the sources of the supply of, the analysis of, and the rate of consumption of water, and a dissertation on wells and boreholes and pumping machinery. Reservoirs, purification, and softening are discussed, and further chapters deal with distribution, fittings for water mains, fire protection, meters, &c. Although in many respects the book is well balanced, it seems strange that so important a subject as that of centrifugal pumps should be dismissed in a single paragraph, while two or three pages each are devoted to plunger pumps, hydraulic rams, and air lift pumps.

The Law Relating to Industry. By H. Samuels, M.A. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. 1931. Price 15s. net.—To a majority of the individuals connected with management in industry the law is a subject respected, but frequently ignored. The author has obviously taken much trouble in producing a book which is easily understood and covers the salient points of law with which all managers and employers should be familiar. It deals concisely with the following:—The Law Concerning Apprenticeship; The Contract of Employment; Statute Law Concerning Wages; Statute Law Concerning Conditions of Work in Factories and Workshops; Law Relating to Mines; The Law Concerning Employers' Liability for Accidents—Workmen's Compensation; The Law Concerning Trade Unions and Trade Associations; National Insurance of Employees; The Law Concerning Schemes of Co-operation and Voluntary Welfare; and Conciliation and the Settlement of Disputes. It concludes with an excellent index. It will be seen that the book covers an extensive field and cannot fail to serve its purpose to those for whom it was written.

BOOKS RECEIVED.

Handbook of Aeronautics. London: Gale and Polden, Ltd., 2, Amen Corner, E.C. 4. Price 25s. net.

Directory of Papermakers, 1931. London: Marchant, Singer and Co., 47, St. Mary Axe, E.C. 3. Price 5s. net.

The Mechanical Properties of Wood. By G. A. Garratt. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 17s. 6d. net.

Elastic Energy Theory. By J. Van Den Broek, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 22s. 6d. net.

The Law Relating to Industry. By H. Samuels, M.A. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 15s. net.

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The South African Mining and Engineering Year Book, 1931. London: Argus South African Newspapers, Ltd., 72–78, Fleet-street, E.C. 4. Price £1 1s. net.

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The Reclamation of Land from the Sea. By F. M. Du-Plat-Taylor, M. Inst. C.E. London: Constable and Co. Ltd., 10–12, Orange-street, W.C. 2. Price 21s. net.

Wesen, Ursachen und Verhütung der Kohlenstaubexplosionen und Kohlenstaubbrände. By H. Steinbrecher. Halle (Saale): Wilhelm Knapp. Price 6·80 marks net.

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The Machinery of the C.P.R. Liner Empress of Britain.

No. II.*

ARRANGEMENT OF PROPELLING MACHINERY.

In our first article we dealt with the general design of the hull and the arrangement of the passenger accommodation, and gave some details of the lay-out of the tunnel shafting and propellers of the Canadian Pacific liner "Empress of Britain." To-day on page 548 we give a diagrammatic drawing of the steam pipe connections between the boilers and the turbines, and an elevation and plan drawing of the machinery spaces. The principal particulars of the turbines, boilers, and auxiliary generator sets are enumerated in the table given below:—

Propelling Machinery.

Type of machinery:	Quadruple-screw single-reduction Parsons type geared turbines
Total designed output	63,000 S.H.P.
Output of the two inboard turbine sets	42,000 S.H.P.
Output of the two outboard turbine sets	21,000 S.H.P.
Astern power on inboard turbine only	33,600 S.H.P.
Propeller revolutions inboard screws	About 150
Turbine revolutions inboard screws	About 1365
Propeller revolutions outboard screws	About 200
Turbine revolutions outboard screws	About 1795
Reduction ratio	About 9 : 1
Normal service speed of ship	24 knots

Boiler Equipment.

Number of main boilers (eight "Yarrow" type, one "Johnson" type)	Nine
Designed working pressure	425 lb. per sq. in.
Total superheater steam temperature	725 deg. Fah.
Number of auxiliary boilers	Two
Designed working pressure	200 lb. per sq. in.

Auxiliary Generator Sets.

Number of steam sets	Two
Type	B.T.H. turbo-alternators
Normal output	Each 800 kW
Number of oil engine-driven generator sets	Four
Type	Fiat-B.T.H. two-stroke Diesel-driven generators
Normal output	Each 450 kW
Emergency generator sets	One
Type	Parsons Paraffin oil engine-driven generator
Normal output	70–75 kW

The "Empress of Britain" is propelled by four screws, each of which is actuated by an independent set of single-reduction geared turbines of the Parsons type, to which high-pressure superheated steam is supplied by eight "Yarrow" type and one "Johnson" type water-tube boilers, designed to burn oil fuel under combined forced and induced draught, with preheated air and open stokeholds. The turbines, gears and boilers were all constructed at Clydebank, the Yarrow boilers being built to working drawings and designs furnished by Yarrow and Co., Ltd. The machinery has been designed to maintain a normal speed of 24 knots continuously.

As shown in Figs. 5 and 6, page 548, the engine-room is divided into three compartments, the forward one being the auxiliary engine-room, containing the I.C. generator sets. The propelling machinery driving the inboard screws is grouped in the forward main engine-room, and that driving the outboard screws in the aft main engine-room. The use of the vessel for fast Transatlantic passages during the summer months and for world cruises in the winter months, under which conditions she will operate as a twin-screw ship with the inboard turbines only in operation, was referred to in our last article.

The turbines drive the propellers through single-reduction gearing, each set comprising one high-pressure, one intermediate-pressure, and one low-pressure turbine, arranged in series. Each turbine drives a separate pinion which engages with the main gear wheel. For astern running a high-pressure unit is incorporated in the same casing with each of the intermediate ahead turbines and a low-pressure unit in the exhaust end of the low-pressure ahead turbines of the inner shaft turbines only, no provision being made for astern working on the outer shafts, these being employed exclusively for ahead duty. The astern turbines develop 80 per cent. of the inboard turbine service power. All the high-pressure turbines are constructed to withstand a maximum working pressure of 425 lb. per square inch and an initial steam temperature of 725 deg. Fah. A view of one of the smaller outboard turbine units is reproduced in Fig. 7 and we may call attention to the well-designed and robust supporting pedestals which form a connection to the structure of the hull.

The high-pressure ahead turbines are of the impulse-reaction type. There are stainless steel blades in the impulse wheels and end-tightened blades of Monel metal in the reaction parts. The intermediate-pressure ahead and low-pressure ahead turbines are of the reaction type throughout, the blades being of phosphor-bronze. In the two inboard turbines the high-pressure and low-pressure astern turbines are of the impulse type with stainless steel blades. Owing to the high temperature of the steam, the turbine casings are made of cast steel with the exception of the low-pressure turbine casings, which are of cast iron. In order to eliminate vibration all the rotors were dynamically balanced, and the running of all the sets is noticeably quiet. The low-pressure ahead turbines are of the double-flow balanced type, while on each of the other turbine rotors a dummy is fitted to reduce the end thrust caused by the steam pressures.

* No. I. appeared May 8th, 1931.

THE PROPELLING MACHINERY OF THE C.P.R. LINER "EMPRESS OF BRITAIN"

JOHN BROWN AND CO., LTD., CLYDEBANK, ENGINEERS

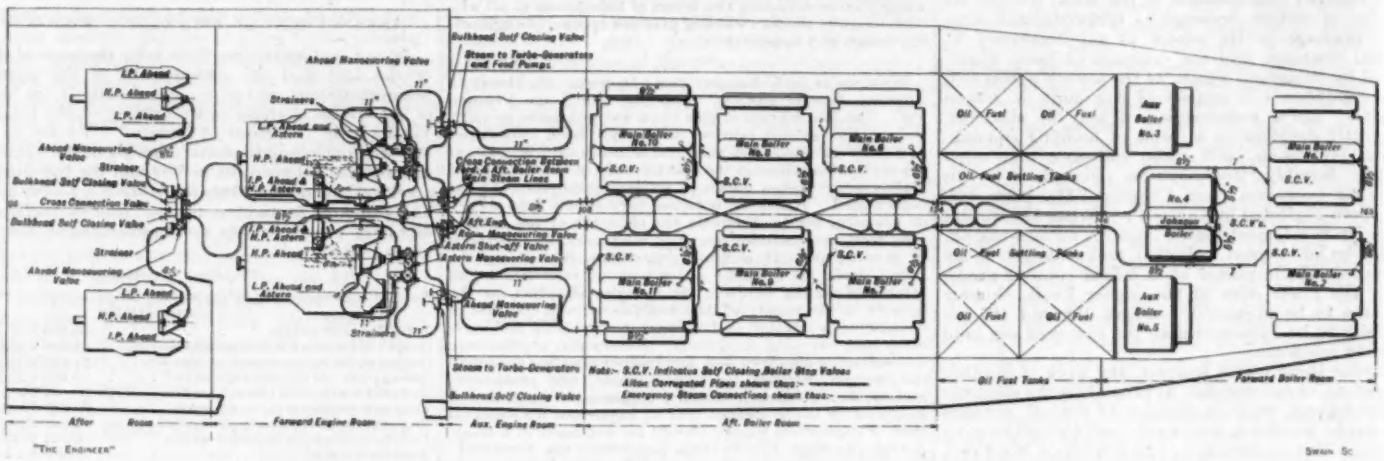


FIG. 4—DIAGRAMMATIC ARRANGEMENT OF MAIN STEAM PIPE LINES AND CONNECTIONS

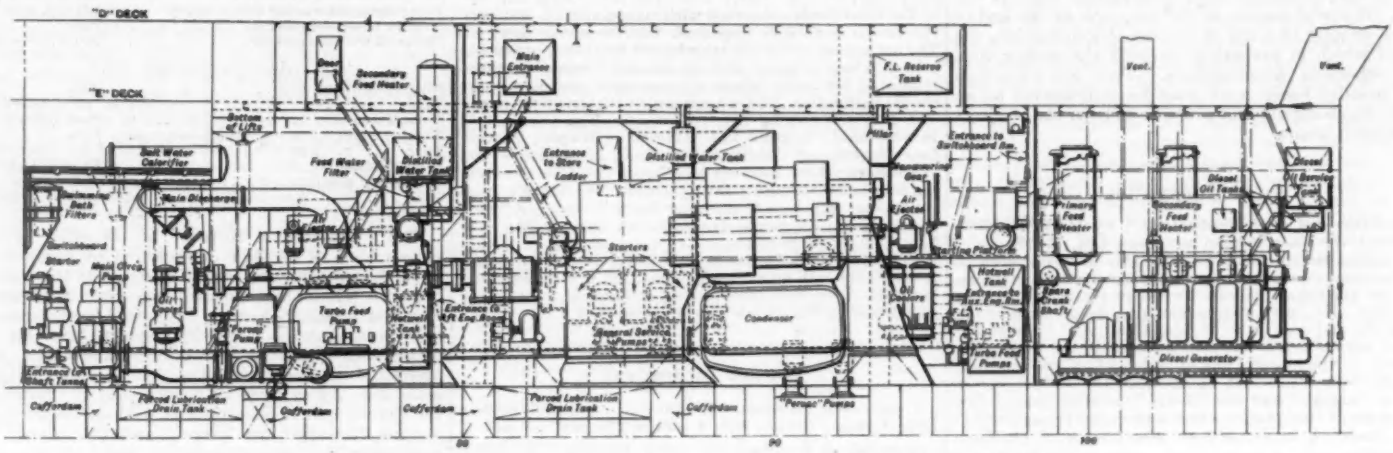
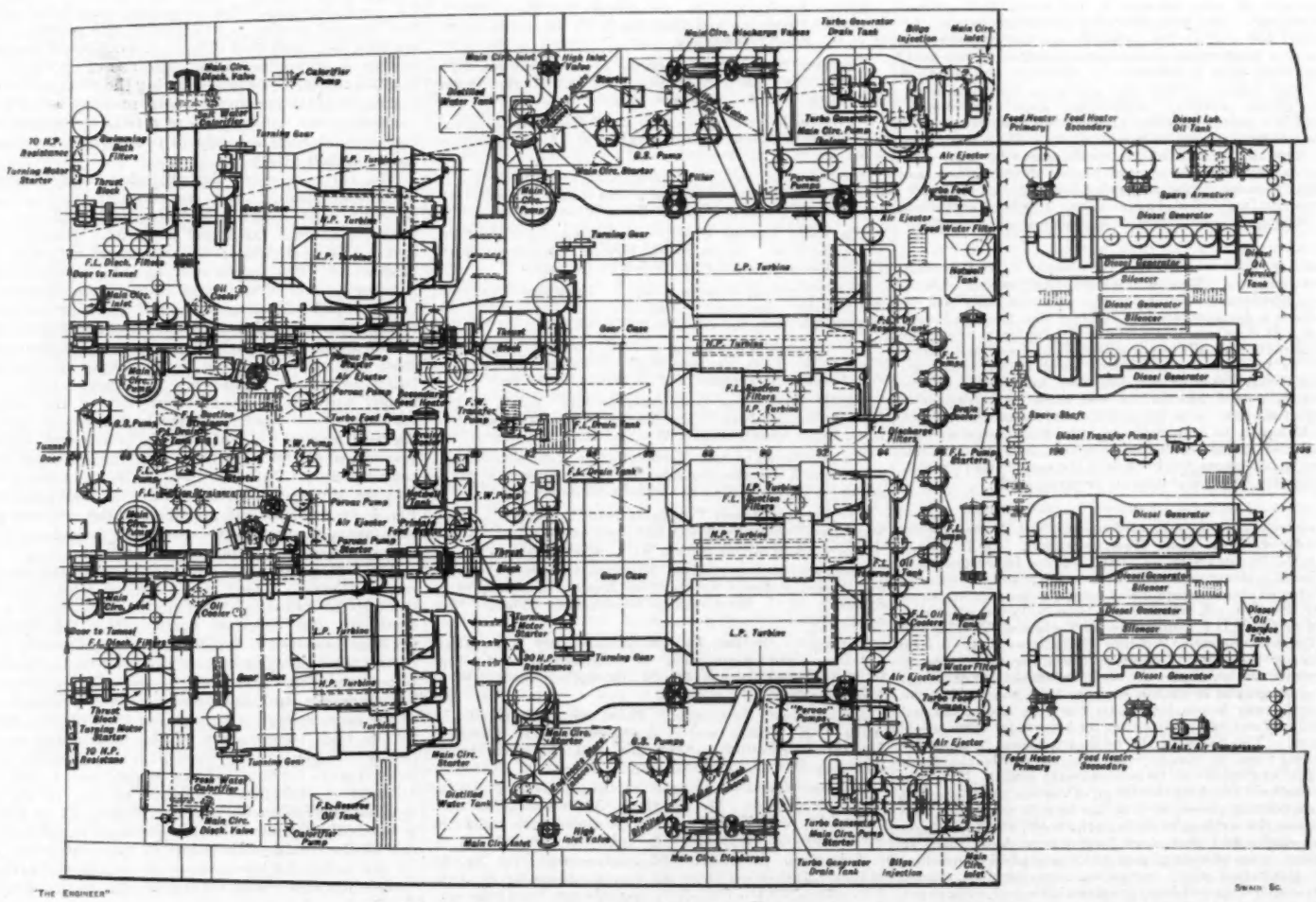


FIG. 5—ELEVATION OF AFTER, FORWARD, AND AUXILIARY ENGINE ROOMS



"THE ENGINEER" SWAN Sc.

FIG. 6—PLAN OF ENGINE ROOMS

Thrust bearings of the "Michell" spherical seated type are provided on each rotor in order to take up any axial thrust which may remain.

On each set the high-pressure turbine is equipped with the Cockburn-Aspinall patented governor, which is combined with a fore-and-aft movement indicator and control gear; but the intermediate-pressure and low-pressure turbines are furnished with fore-and-aft indicators and controls only. With this arrangement, which is illustrated in Fig. 8, the steam is shut off in the event of the turbine revolutions exceeding a certain speed. The fore-and-aft movement indicators and controls indicate any axial movement of the

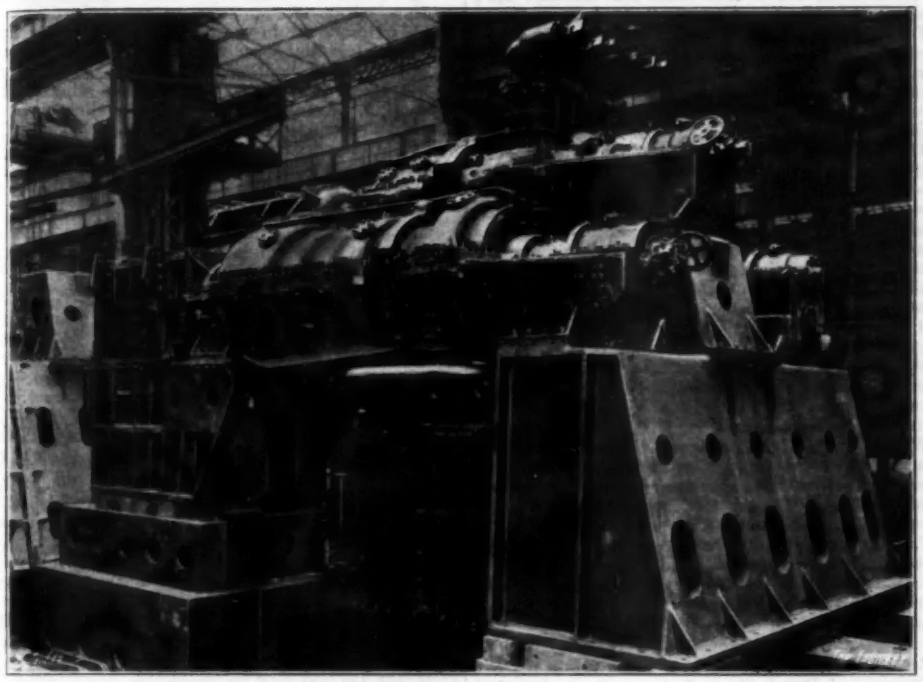


FIG. 7—OUTBOARD TURBINE-UNIT WITH CONDENSER AND GEARCASE

turbine rotors, and if this movement should at any time become excessive owing to undue wear on the thrust pads the control gear operates a pilot valve on the oil relay cylinder which is fitted near to the Cockburn-MacNicoll bulkhead self-closing valve and so shuts off steam to the turbines. Steam is also shut off by the same valve if the oil pressure in the lubrication system drops unduly or fails entirely, owing to any stoppage of the forced lubricating pumps or through any other cause. As will be seen from the drawing below, the gear is provided with a resetting lever for testing for the presence of oil at the governor valves when the turbine is stationary. This lever

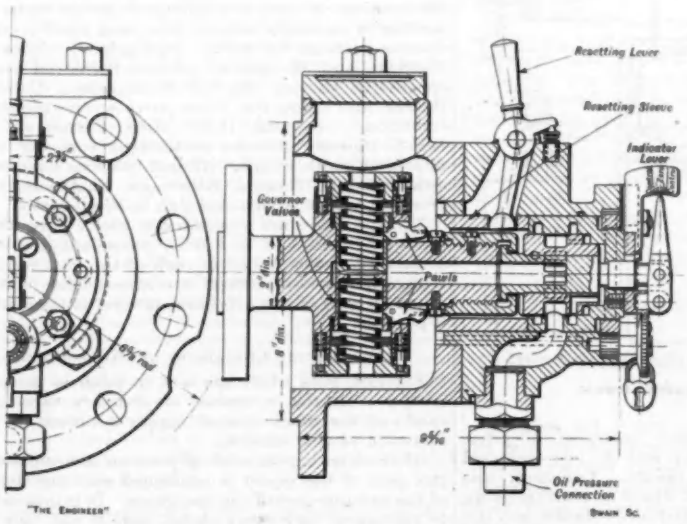


FIG. 8—SECTION THROUGH ASPINALL GOVERNOR

moves the resetting sleeve, depressing the pawls, and thereby slightly opening the valves, which releases the oil pressure in the system and so causes the emergency shut-down valve to close.

The normal service running speed is 1795 r.p.m., and the governor automatically comes into action at 2065 r.p.m. The principle upon which the governor works will be clear from our illustration Fig. 8. There are two hollow plungers or valves, whose ends abut each other. They tend to fly apart under centrifugal action, but are restrained by springs. Whilst the two faces are in contact the oil which is under forced lubrication system pressure cannot pass, but as soon as they separate a leakage occurs, which lowers the pressure in the relay system of the emergency self-closing bulkhead valve and shuts down the turbine.

The main gearing is of the usual double helical single-reduction type. In Fig. 10 we give an illustration of one of the main gear wheels of the inner shafts. These wheels are 174in. in diameter, with a face width of 56in., while the pinions are all 19¾in. in diameter. The wheels of the outer shafts are 135½in. in diameter, width of face 26in., and the pinions all 15½in. in diameter. All pinions are connected to the respective rotors by flexible claw type couplings. The thrust of the propeller is transmitted to the hull of the ship by Michell thrust bearings of the single collar type, which are fitted to the main lines of shafting immediately aft of the gearing. For convenience of inspection these bearings have hinged covers.

STEAM MAIN LAY-OUT.

As shown in Fig. 4 on page 548, four lines of main steam pipes are employed, two from the after boiler-room, each conveying the output of three boilers, and two from the forward boiler-room conveying the combined output of the three boilers. All the pipes are led to the control chests situated at the main starting platform in the forward engine-room, valves being provided to permit of the supply of the steam from the three port boilers in the after boiler-room being led to the port inboard turbines, and the steam from the three starboard boilers in the aft boiler-room being led to the starboard inboard turbines. The steam from the three boilers in the forward boiler-room supply the outboard turbines in the after engine-room. The expansion of the steam pipes, owing to the high temperature of the steam, is taken up by corrugated pipe bends, supplied by Aiton and Co., of Derby, and in Fig. 11 we show a typical group of these bends. The steam pipe joints are of the metal-to-metal type, and a feature of the recent extended trials was the steam-tightness of all mains and the easy way in which all expansion was taken up by the bends.

On the starting and manœuvring platform in the after engine-room the manœuvring valves are arranged in a very convenient position for easy operation by the staff on duty. Special cross-over and shut-down valves are provided, the operation of which immediately prepares the machinery for manœuvring purposes by shutting off the outboard turbines in the forward engine-room. Above the starting platform are the usual vacuum pressure gauges and thermometers, also revolution and other indicators. The manœuvring valves are of the Cockburn-MacNicol improved balanced type, and after passing through these valves the steam enters, on its way to the ahead or astern turbines, diverging-converging strainers of the Cockburn patented type.

CONDENSERS AND FEED SYSTEM.

As shown in Fig. 7, the main condensers are slung underneath the low-pressure turbines. They are of

FIG. 10—INBOARD MAIN GEAR WHEEL

the Weir two-flow regenerative type with a large reservoir at the bottom for storing the water required in connection with the successful operation of the closed feed system. A section through one of them is reproduced in Fig. 9. Each inboard condenser has 20,700 square feet of cooling surface, and each outboard condenser a cooling surface of 9600 square feet. The tubes for all condensers are made of cupro-nickel and have been supplied by Allen, Everett and Co., Ltd. A particular feature of the condensers is the water doors, which have been designed to facilitate the quick examination of the tubes. Large hinged doors have been fitted in each end of the condensers; they are jointed with rubber rings recessed into the casing and secured by swivel bolts and dogs, which may be removed for inspection purposes in a few minutes. Between the condensers there is a large

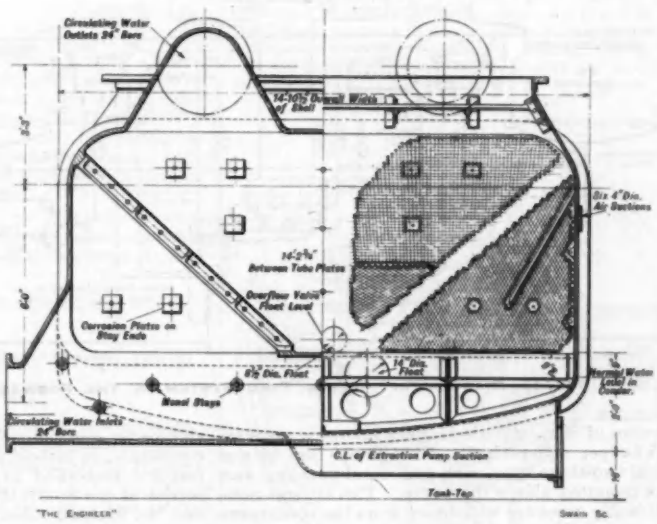


FIG. 9—SECTION THROUGH CONDENSER

space left for the convenient handling and cleaning of tubes.

In both forward and after engine-rooms a Weir closed feed system of the internal capacity type has been installed. The drawing which we reproduce in Fig. 12 shows a diagrammatic arrangement of the system for the forward engine-room. It will be noted that the evaporation of the raw feed takes place in the Scotch boiler according to the Howden-Buell duplex boiler feeding system, the steam being led to an intermediate stage of the main turbines.

Tracing the path of the water through the system, it will be seen that the port and starboard condensers are fitted with condensate wells and the level of

the water in them is maintained by a float-operated supplementary feed valve. The condensate is withdrawn by means of motor-driven extraction pumps and circulates through a drain cooler, in which the heat of the drains from the primary heaters is absorbed before the feed enters the suctions of the feed pumps. The latter are of the firm's turbine-driven type and discharge the feed through the primary and the secondary surface feed heaters, taking bled steam from the turbines at low and medium pressures, to the high-pressure boilers through automatic feed water regulators of Weir and Mumford types. Should the water level in the condensers fall owing to a sudden demand by the feed pumps, water is drawn from a feed tank into the condensers through the operation of the supplementary feed valves. As the efficiency of a

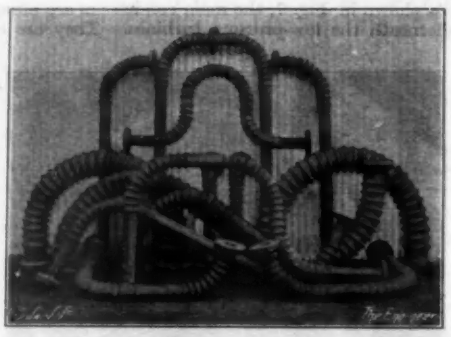


FIG. 11—TYPICAL GROUP OF CORRUGATED BENDS

closed feed system of this type depends, from the standpoint of the absence of corrosion, on the action of the condenser as a de-aerator, the regenerative system is advantageous, as it delivers the condensate at practically the temperature corresponding to the vacuum and with a very low oxygen content. Any feed water drawn up is thus completely de-aerated before entering the main circuit. In the event of the water level rising, the excess feed is withdrawn from the system through overflow valves, also float-operated.

The motor-driven extraction pumps are of the Drysdale "Pervac" type, two pumps being fitted for each condenser. Each pump is designed to deal with 120,000 lb. of condensate per hour when drawing from a vacuum of 29in. and discharging against a pressure of 25 lb. per square inch. The pumps are of the vertical two-stage type, with gun-metal impellers and rotors mounted above the pump. The air and non-condensable gases are withdrawn from the condensers by means of Weir steam jet air ejectors, three-stage type, circulated with cold sea water, with the steam nozzles of Monel metal. The condensate passes to the drain coolers, which are of 460 square feet surface. The coolers are designed for raising up to 200,000 lb. of feed water per hour from 82 deg. Fah. to 107·8 deg. Fah., when working under full power conditions, the heating medium being the drains from the primary heaters. There are four turbo-feed pumps fitted in pairs, port and starboard, one working and one standby, each pump being capable of delivering 200,000 lb. of feed water per hour against a pressure of approximately 500 lb. per square inch. They are supplied with steam at 400 lb. per square inch, superheated to 725 deg. Fah., and exhaust to the main condensers, or against a pressure of 15 lb. per square inch to the primary heaters. The pumps are of the two-stage type with Monel metal impellers and diffuser rings.

From the turbo-feed pumps the feed water passes through primary surface heaters of the multi-flow type with 670ft. of surface, which are designed to raise the feed from 114 deg. Fah. to 230 deg. Fah. when supplied with steam bled from the turbines at a pressure of 30 lb. per square inch absolute plus the drainage water from the secondary heaters. Solid-drawn copper tubes expanded into cast steel headers form the heating surface. The secondary heaters are also of the Weir multiflow type, each having 560 square feet of surface, and each heater being designed to be capable of raising the feed from 230 deg. Fah. to 320 deg. Fah. when supplied with steam bled from the turbines at a pressure of 110 lb. per square inch absolute.

For feeding the Scotch boilers, which supply make-up and auxiliary steam, a pair of direct-acting auxiliary feed pumps are provided, with an auxiliary heater designed to raise the feed temperature up to 220 deg. Fah. with exhaust steam from the auxiliaries delivered at a pressure of 15 lb. per square inch.

The feed system in the after engine-room is on similar lines to that above described, but the capacity of each condenser is approximately half of that of the forward sets. One extraction pump is fitted for each condenser with one turbo-feed pump serving the system and one for a standby. One set of primary and secondary heaters similar to the forward sets and of similar dimensions is provided. The feed filters, we noted, were six in number, two in the forward port and two in the forward starboard engine-rooms and one each in the after port and starboard engine-rooms. They are of the Hocking "Climax" high-pressure pattern. Throughout the trials a very high degree of vacuum was maintained, and the feed system operated with the greatest satisfaction.

With regard to the paragraph in our last article referring to model tests, we regret that we were in error in stating that tests had been made at the National Froude Tank at Teddington. Although the services of this tank were employed for some previous C.P.R. ships, the actual lines of the "Empress of Britain" were determined solely from careful and repeated model tests and experiments which were carried out by John Brown's staff at the Clydebank tank.

An interesting function took place on board the "Empress of Britain" on Tuesday last, when Mr. John Johnson, the Chief Superintendent Engineer, invited representatives of the principal shipbuilding companies, along with marine engineers, naval architects, and superintendent engineers of other companies, to inspect the ship and the new technical features embodied in her design. Luncheon was served at the South-Western Hotel at Southampton, and Mr. Richard Allen thanked Mr. Johnson and the Canadian Pacific Company for the opportunity afforded of visiting the ship. Considerable interest was displayed in the Johnson two-drum water-tube boiler, to which we shall refer in our next article.

(To be continued.)

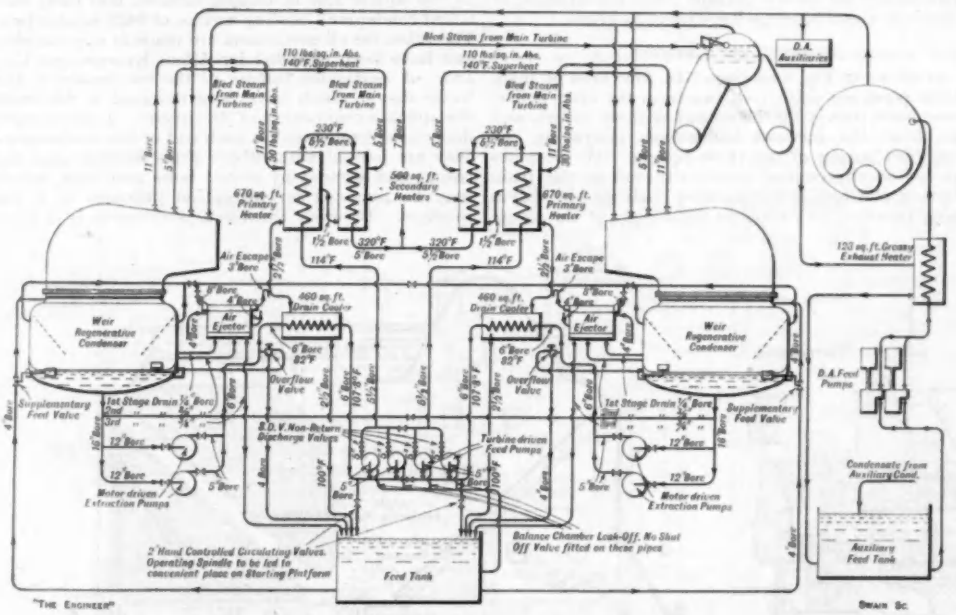

Bled Steam from Main Turbine
110 lbs/sq. in. Abs. 140°F. Superheat
D.A. Auxiliaries
230°F
320°F
114°F
670 sq. ft. Primary Heater
560 sq. ft. Secondary Heaters
460 sq. ft. Drain Cooler
Air Ejector
Weir Regenerative Condenser
Overflow Valve
Supplementary Feed Valve
Turbine driven Feed Pumps
Motor driven Extraction Pumps
D.B.V. Non-Return Discharge Valves
Balance Chamber Leak-Off. No Shut Off Valve fitted on these pipes
2" Hand Controlled Circulating Valves. Operating Spindle to be led to convenient place on Starting Platform
Feed Tank
120 sq. ft. Ground Exhaust Heater
D.A. Feed Pumps
Condensate from Auxiliary Cond.
Auxiliary Feed Tank
"THE ENGINEER"

FIG. 12—DIAGRAM OF CLOSED FEED SYSTEM IN THE FORWARD ENGINE ROOM

THE past quarter, says the *F.B.I. Barometer*, witnessed a perceptible improvement in the domestic situation of the principal industrial countries. While this improvement was due primarily to seasonal causes, it has helped to confirm the impression that the worst of the slump is over. Unemployment in industries catering for home consumption has decreased, and the world price level has shown some signs of recovery. We still adhere to the view that the process of recovery must be slow, and that premature optimism can only lead to disappointment.

The Corrosion of Iron and Steel.

No. II. (*Conclusion*).*

FIELD TESTS.

IN the field tests, different types of iron and steel, specially prepared for the purpose under the supervision of the Committee, will be exposed to atmospheric corrosion under a variety of conditions. The variables considered include :—

(1) Differences in the chemical composition of the material.

(2) Physical differences in the materials, resulting from differences in rolling temperatures and other factors.

(3) Differences in the nature of the surface, *i.e.*, tests on material as rolled, machined, sand-blasted, pickled, or polished.

(4) Tests on protected surfaces, whether by painting, galvanising, electro-deposited coatings, or other methods.

(5) Differences in conditions of exposure, *e.g.*, climatic conditions. This has been provided for by arranging tests at a number of different stations in various parts of the world.

The experimental programme has been divided into several parts, of which the first three are as follows :—

Part 1.—Tests on mild steel—0·2 per cent. carbon, 0·6 per cent. manganese—with and without copper additions.

Part 2.—Tests on wrought iron and ingot iron.

Part 3.—Tests on the effect of different processes of manufacture on the corrosion of mild steel.

Part 1 is now in progress, whilst Parts 2 and 3 are in active preparation.

The size of specimen to be used for field tests was fixed at 15in. by 10in. by ⅛in., after thorough discussion by the Committee, from which, incidentally, it appeared that individual members were in the habit of testing anything varying from several yards to a few inches square, according to their own inclination in the matter. A specimen of this size weighs about 16 lb. in mild steel, and has a reasonably representative area without being too unwieldy. The thickness, ⅛in., is probably sufficient to ensure that any strains due to rolling are eliminated before the specimen has had time to cool down.

The total number of specimens to be tested is very large, and it is clearly necessary to have a reliable method of identification. Since any marks punched on the surface might be obliterated by rust in the course of time, a method, in which the specimens are identified by means of two holes drilled through them, has been adopted.

The report then specifies the standard conditions for preparing the specimens. Paints, too, are discussed. It was decided that since no comparison of the effectiveness of paints was required, only two should be used—red lead and red oxide. Standard conditions for the application of the paint are included.

EXPOSURE STATIONS.

In order to obtain as wide a variety as possible in the weather conditions experienced, and, through the kindness of several public and private bodies, a number of exposure stations have been fixed upon in various parts of the world. In England, Woolwich, Sheffield, and Motherwell provide industrial atmospheres of varying degrees of intensity; Calshot, Redcar, and Llanwrtyd Wells provide various marine conditions; and the Dove Hole Tunnel on the L.M.S. Railway provides particularly corrosive conditions of another type. Abroad, stations have been established at Basrah, Khartoum, Singapore, and Durban, and at Apapa and Aro in West Africa.

The specimens are suspended in racks, adequately spaced, by means of 10 S.W.G. galvanised steel wire attached to holes drilled in each of the four corners. Pollution measurements of the atmospheres will be taken at each of the exposure stations as far as that is possible.

FIELD TESTS: CORROSION OF MILD STEEL.

The first tests which are now in progress are concerned with the corrosion of ordinary structural steel and the effect of small copper additions on the corrosion of this material.

After reviewing the work of previous investigations, this part of the report is concerned with the details of the manufacture of the specimens. It is impossible to reproduce here every detail, and it can only be stated that from beginning to end a minutely detailed record is kept.

Provision was made at four of the stations for exposing sets of specimens that had been painted, after having been allowed to weather for a short period. A number of specimens were weathered on the roof of the Brown-Firth Research Laboratories, Sheffield, for thirty-six days in October and November, 1930. The appearance and weights are given in tables, and the following conclusions are reached :—

"Subject to subsequent experimental results, it would appear from this evidence that, in the case of steelwork that is to be painted, the effect of rolling temperature on the properties of the scale produced is probably of greater importance than the effect of

* No. I. appeared May 8th.

the presence of copper or otherwise in the steel, and it seems reasonable to expect more satisfactory service in the painted condition from the specimens finished at a low rolling temperature and with a red scale, than from those finished at a high temperature having a black scale. It is clearly shown, from the data adduced, that the loss in weight on weathering for a short period is not determined by the copper content, and that in this case the rolling temperature rather than the composition of the steel appears to be the determining factor."

Details and examples to date of the appearance, &c., of other specimens are given. The Committee states that this section of the report has necessarily been more concerned with experimental details than with actual results, but, as will have been seen, the scheme is well under way, and the whole of the tests forming Part I. of the work should be in hand by the end of 1931. As regards the tests on wrought iron and ingot iron, forming Part 2 of the programme, arrangements have already been made for the supply and preparation of the necessary materials, and it is hoped that work will also have been commenced on this series by the end of this year.

Laboratory Tests.

A sub-committee was formed to study the value of Laboratory Corrosion Tests.

The sub-committee has so far confined its attention to the problem of devising a suitable laboratory test for atmospheric corrosion, and, with this object in view, the following experimental work has now been carried out :—

(1) Investigations on possible laboratory corrosion tests—at Cambridge by Mr. U. R. Evans and Mr. S. C. Britton.

(2) Investigation to determine the value of the proposed laboratory tests—at the Brown-Firth Research Laboratories, Sheffield, by Dr. W. H. Hatfield and Mr. H. T. Shirley.

(3) Laboratory corrosion tests—at Birmingham, by Dr. J. C. Hudson.

The first series of tests, by Evans and Britton, was designed to examine the suitability of various possible types of laboratory tests. As a result of their work, they were led to recommend the adoption of an intermittent spray test, using a dilute (N/100) sulphuric acid solution to simulate industrial conditions and a 3·5 per cent. sodium chloride solution to represent marine conditions. The intermittent spray test differs in a fundamental manner from most previous types of spray test in that the specimens are allowed to dry in the open air or indoors between consecutive sprayings and are not confined in a box, where they may never get dried properly.

As a result of this work the sub-committee came to the conclusion that, in view of the difficulties of reproducing sprays and of possible errors due to the personal factor, the results of all laboratory tests should be expressed in terms of a standard material tested alongside the others.

In the second series of tests, Hatfield and Shirley investigated further the possibilities of the intermittent spray test by making a direct comparison of the results obtained for a large number of materials in different surface conditions subjected both to the spray test and to atmospheric corrosion in an industrial atmosphere. They introduced a mechanical method of spraying, which is independent of the personal element and probably more reproducible than the hand sprays used in the other two investigations.

The third series of tests, carried out by Hudson, had the object of elucidating several important points, such as the degree of reproducibility of different hand sprays and of the standard specimens themselves. In addition, since it appeared probable from the results of Evans and Britton that the intermittent spray test gave the correct order of merit of specimens exposed to corrosion for a limited period—the "short period" order of merit confined to the initial stages of corrosion, which is probably of much importance in the case of materials to be used in the painted condition—arrangements have been made to correlate the results of intermittent spray tests on a number of different materials with field observations on the same materials exposed in the painted condition. Since a prolonged period of exposure is needed to bring about failure in the case of painted specimens, it will necessarily be some time before this correlation can be made.

Conclusions Drawn from Laboratory Tests.

(1) The three researches were directed towards different parts of the problem. The preliminary series at Cambridge employed only a small number of materials, but tried out a large number of different forms of testing. Of these, the two forms which gave most promising results were adopted in the Sheffield series, and applied to a very much larger number of materials. The Birmingham series—besides forming a valuable check on the two others—included a study of two most important problems, namely, the comparison of different sprays, and the claims of the Committee's "standard mild steel X" to serve as a standard material.

(2) The type of "intermittent spray test" adopted differs from the usual "continuous spray test" in that the specimens are only sprayed at intervals, and are "hung up to dry" in between the sprayings. Thus the tests allow full play to two factors which are known to affect the corrodibility of the materials under service conditions, but which are not allowed to produce their effect in the continuous spray test, when the specimens are kept wet all the time. These factors are (*a*) the hygroscopic nature of certain corrosion products ; (*b*) the effect of loss of moisture on the physical character of the rust.

(3) All the various experimenters obtained good agreement between duplicate experiments when using scale-free materials. This is a matter of satisfaction, since reproducibility in corrosion work has often been a matter of difficulty. With scale-covered materials, good reproducibility can hardly be expected, since the fraction of the area covered with scale usually varies between duplicate specimens of the same material.

(4) Reproducibility is only obtained, however, if the same spray is used for all specimens throughout a research. Different sprays, even if purchased from the same maker, may deliver different amounts of liquid and accordingly produce different amounts of corrosion. Thus in order that one experimenter, using one spray, shall be able to link up his results with those of another experimenter, using another spray, it is essential that specimens of the standard steel shall be introduced into each series of tests. It has been shown that the Committee's standard mild steel X possesses all the requisites of a standard material, and that reproducible results are obtained with it, even when some of the specimens employed have visible surface defects.

(5) A comparison between (*a*) the "order of merit" of a series of materials obtained in the laboratory tests, and (*b*) the order of merit of the same materials in the field tests—*i.e.*, exposure to the atmosphere out of doors—shows fair but not perfect agreement. It is concluded that laboratory tests are of value in bringing out the effect of factors which have a notable influence on corrosion ; for instance, the laboratory tests reproduce the effect of copper in reducing the rate of corrosion in short-period field tests.

(6) It is impossible to lay down a single test which would serve all purposes. The sub-committee considers that immersion tests are not suitable for indicating relative resistance to atmospheric corrosion. For this purpose, they would provisionally recommend for general use in an industrial laboratory an intermittent spray test similar to that used by Dr. Hatfield and Mr. Shirley. The following details of procedure are recommended :—

(*a*) Instead of the ebonite spray, a glass spray may be used. The same spray shall be applied to all materials to be compared in a given set of tests, and, if it is desired to correlate results with those of tests conducted elsewhere, specimens of the standard steel shall be included in the series.

(*b*) For industrial purposes, the weight increment is sufficiently accurate as an index of corrosion, provided that care is taken that the rust does not drop off. It is not necessary to wash free from salt or acid—any error will be the same for all specimens, and will not affect the order of merit.

(*c*) The spraying shall be carried out once a day for five days a week, the period of the test being four weeks.

(*d*) The liquid used in the spray, in absence of special reason to the contrary, should be either N/100 sulphuric acid or 3·5 per cent. sodium chloride solution. The former is generally preferable where the materials are likely to be exposed in practice to urban atmospheres, and the latter where they are likely to be exposed to marine atmospheres. But it is noteworthy that at Sheffield, a salt spray gave an order of merit closer to that obtained in the field test than the acid spray.

In the laboratories where no compressed air is available, intermittent spraying in the same manner by means of a hand spray may be regarded as satisfactory.

The Voith-Schneider Propulsion System.

On page 527 of last week's issue of The Engineer, we gave the outline programme of the Summer Meeting of the Society of Friends and Patrons of the Hamburg Experimental Tank, which, this year, is to be held in South Germany and Switzerland from May 27th to May 29th. One of the principal items of interest in connection with the visit to Lake Constance will be the inspection both on the stocks and in service of the four new motor ships "Kempten," "Augsburg," "Ravensburg" and "Baden," designed for the Lake Constance service of the German State Railways, and equipped with the Voith-Schneider system of propulsion. During the meeting two technical papers, dealing with the system and its application, are to be read and discussed, after which the vessels will be inspected and a series of trials carried out. By the courtesy of Dr.-Ing. E. Foerster, the Editor of *Werft-Reederei-Hafen*, we are able to give in what follows a description of the new system, based on an article which appeared in that journal on April 15th last.

The four new motorships referred to above are all propelled by high-speed oil engines, which drive a twin arrangement of Voith-Schneider propellers. The first two ships, the "Kempten" and the "Augsburg," were built by the Deggendorfer Werft und Eisenbau G.m.b.H., of Deggendorf, while the "Ravensburg" and "Baden" were constructed by the Bodanwerft Kressbronn. The "Kempten," which has been in service since Easter this year, has a length of 47 m., or about 154ft. 3in., with a beam of 9 m., or 29ft. 6in., with a draught of 1·55 m., or 5ft. 1in. Her displacement is about 230 tons, and she is designed to carry 400 passengers in two classes, her designed service speed being 24 kiloms., or about 15

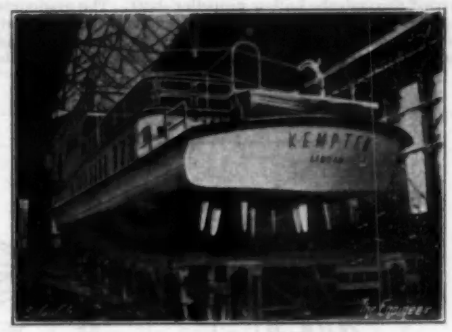


Fig. 1—Stern View of Ship

miles per hour, and her maximum speed 25 kiloms., or a little less than 16 miles per hour. In both the "Kempten" and the "Augsburg" the engines employed are two non-reversing, eight-cylinder, four-stroke M.A.N. motors, each having a designed maximum output of 200 B.H.P. at 900 r.p.m. The sister ships, the "Ravensburg," and the "Baden," will be engined by the Mannheimer Motorenwerke. A stern view of the "Kempten" is reproduced in Fig. 1, while in Fig. 2 a nearer view of the port propeller unit is given, showing the four-bladed arrangement employed. The engines drive the propeller

Fig. 2—Port Propeller Unit

gearing through shafts 18 m., or about 59ft. long, with a diameter of 90 mm., or 3½in. As the drawings 4 and 5 indicate, a combined arrangement of spur and bevel gearing is used. With the propeller shaft A running at its normal speed of 900 r.p.m., the first reduction, or horizontal, shaft B turns at 340 r.p.m., and the second reduction, or vertical, propeller disc shaft C at 170 r.p.m. The letters given to different parts in the article refer to those shown in Figs. 3, 4 and 5.

It will be seen that each propelling unit may be regarded as a horizontal propeller, and the mechanism must,

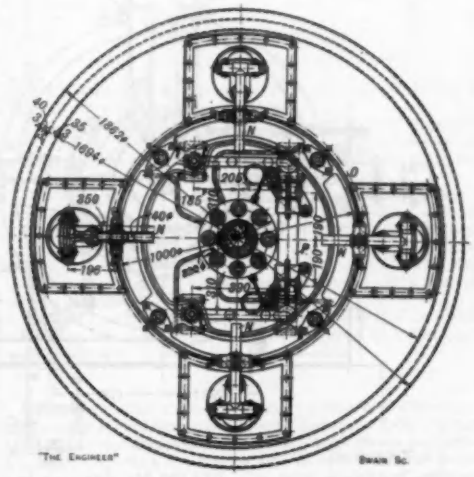


Fig. 3—Plan of Propeller Disc

therefore, give rotation and cause the blades to "feather" during part of each revolution. By altering the phase of the feathering manœuvring of the vessel is effected.

The vertical propeller disc shaft C is housed in the bottom guide bearing D, and upper combined thrust and guide bearings E and F. These three bearings are combined in one housing along with the gearing, so that the turning moment of the propeller and the thrust are transmitted to the hull of the ship at the three points G, H and I. At the bottom end of the shaft C there is attached by means of a flange the steel wheel form casting K, which carries the four removable propeller blade bearings L. The blades

themselves, M, are forged from rustless steel, and are shaped as indicated in Fig. 2, the surfaces being finished bright by grinding. The double supported blade shaft is forged in one piece with its blade, and the design of it is such that each of the four blades can be unshipped separately and withdrawn upwards for examination, without having to dock the ship.

Into the upper parts of the blade spindles are fitted the conical-socketed links and pins N, which are attached to the manœuvring ring O. All the moving parts of the propellers and gearing, together with the bearings on the links N, are provided with forced lubrication, which is carried through the hollow propeller shaft. The manœuvring ring O is so disposed that it revolves synchronously with the casting K, but that it is free to move either concentrically or excentrically with relation to the propeller disc shaft C. If the ring moves concentrically with the shaft the blades remain tangential, and there is no movement relative to the wheel K, so that even with the engine running there is no propulsive action given. As soon, however, as the manœuvring ring is made to revolve excentrically to the disc shaft, the links N cause the blades to move angularly and excentrically to the wheel, thereby creating a propulsive stream, the direction and strength of which depends on the instantaneous position of the manœuvring ring relative to the shaft.

For the control of the manœuvring ring there are three oil-operated servo-motors—R, S and T—provided, which, in turn, are controlled directly from the bridge through telemotor gear. The link mechanisms are so arranged that when the hand wheel, which is practically vertical, is turned in a particular direction, the ship moves in the same direction, independently whether she is going ahead or astern. The movement of the hand wheel allows the ship to be turned on her own axis. Alongside the hand wheel there is a lever controlling the speed of the ship, either ahead or astern. By altering the angular movement of the blades through the manœuvring ring, by means of the servo-motors, it is possible to give the vessel a wide variation in speed, either ahead or astern, even though the propeller discs are allowed to revolve at a constant speed.

A third lever with a transverse movement provides a means of setting the propeller blades so that the vessel is moved parallel to itself—a manœuvre which is most valuable when making and leaving piers and wharves.

From what has been said above it will be seen that with the Voith-Schneider system of propulsion no rudder or steering gear is necessary. It may be stated that the mechanism described has been developed and patented by J. M. Voith, of Heidenheim and St. Pölten, the machinery being manufactured at the company's latter works. It may be mentioned in this respect that Messrs. Voith are represented in London by Perrins, Ltd., of 3, Central Buildings, Westminster, S.W. 1.

In addition to the two papers which are to be read at the meetings referred to, a full programme of comparative tests has been arranged, the results of which it is hoped will be available for later publication. It may be recalled that on October 10th last year the first large ship to be propelled on the Voith-Schneider principle was completed for the Bayerische Lloyd Danube service. She was the motorship "Uhu," of about 80ft. in length and 30ft. beam, propelled by a 700 B.H.P. M.A.N. oil engine. This vessel has, we understand, performed her towage duties on the Danube with every satisfaction, and has demonstrated the great flexibility given by the new drive. The setting to work of four railway steamers similarly propelled, and the very complete tests which are to be carried out with them, mark an interesting development in ship propulsion.

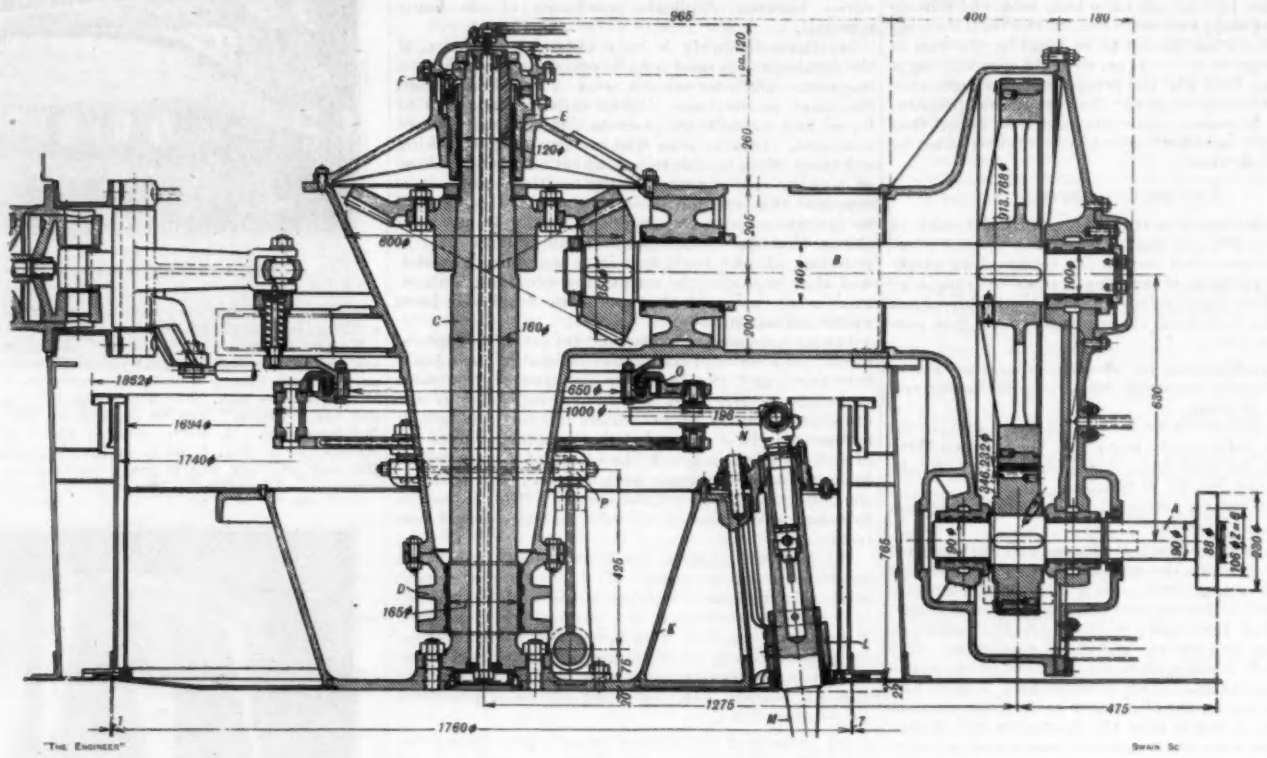


FIG. 4—GEAR DRIVE FOR THE VOITH-SCHNEIDER PROPELLER UNIT

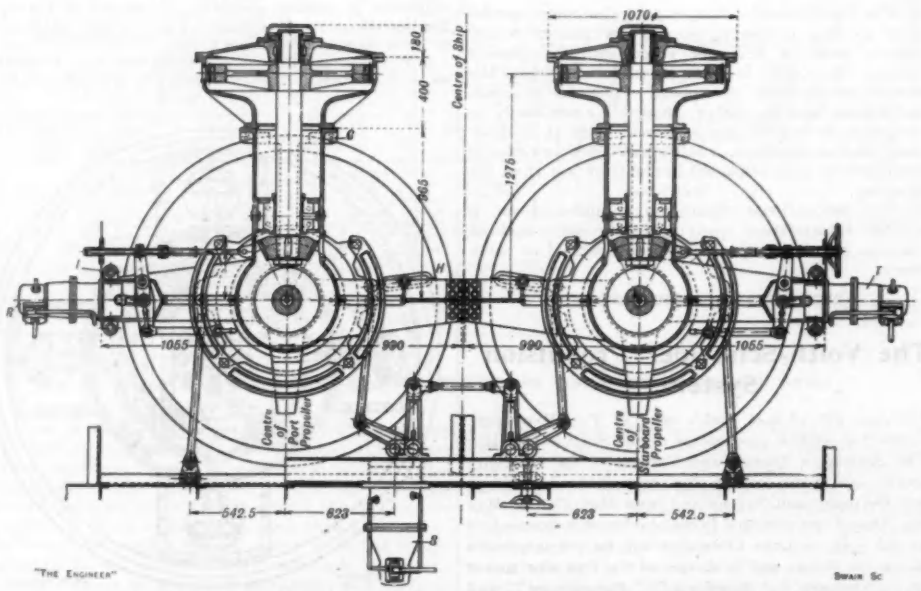


FIG. 5—PLAN OF PROPELLER UNITS SHOWING SERVO-MOTOR CONTROLS

THE port of Paysandú, 214 miles north-west of Montevideo, a terminal port of Uruguay, has been opened to ocean-going vessels. It is proposed to construct a navigable channel, 23ft. deep, running from the east of the port to the Rio Uruguay.

Books of Reference.

Metals and Alloys. The Louis Cassier Company, Ltd., 22, Henrietta-street, W.C. 2. 1931. Price 10s. net.—The last edition of this book was published in 1920, and contained particulars of some 500 non-ferrous alloys. The present edition deals with the composition of about 3500. An up-to-date edition of this book has been badly needed for some time, owing to the amazing manner in which the science and practice of metallurgy has developed, particularly in the direction of nickel and aluminium alloys, during the last decade. The contents of the book are as follows:—Percentage Composition of Non-ferrous Alloys; Breaking Strength of Metals and Alloys; Particulars of all the Known Metals; Electro-chemical Equivalents of Metals, and Specific Resistances of Metals and Alloys. There are listed in certain cases alloys no longer in commercial use, but which have been included to make the list complete. The publishers are to be congratulated upon having produced a book of definite value and one which will be indispensable to all firms and individuals connected with the metal industries.

The Directory of Shipowners, Shipbuilders and Marine Engineers. 1931. The twenty-ninth edition. Published by the Directory Publishing Company, Ltd., 33, Tothill-street, Westminster, London, S.W. 1. Price 20s. net.—This handy book, which has been specially designed for either desk or travel use, affords ready reference to the facilities which are offered by shipowners, shipbuilders and marine engineers in all parts of the world. The name of a ship, and where she was built and engined, with particulars of her tonnage, draught and age, in addition to other items, are given. The capacity of the various shipyards, both at home and abroad, is also given, together with the names of the directors and the leading officials of all the shipowning and shipbuilding companies. Particulars of the Board of Trade and Ministry of Transport Departments and the various classification societies are included, together with lists of consulting naval architects and marine engineers, and the various institutions and technical societies associated with shipping and the shipbuilding and marine engineering industries. A good feature of the directory is its comprehensive system of indexing, which is of great assistance to rapid reference. We have no hesitation in recommending this book, which is compiled under the personal direction of the Editor of our contemporary journal the *Shipbuilding and Shipping Record*.

The Motor Boat Annual, 1931. The tenth edition. Published by Temple Press, Ltd., of 5-15, Rosebery avenue, London, E.C. 1. Price 5s. net.—This annual volume, which is prepared by the staff of the *Motor Boat*, is designed to cover the whole field of motor boating, including the building of motor boats, the installation of their propelling and auxiliary machinery, and their operation. The practical details of both wood and metal hull construction are dealt with and typical boats and engines, with their auxiliaries, are described and illustrated. A new chapter is devoted to the recently developed high-speed, heavy-oil engine, while the inboard and outboard engines of the newer type have not been neglected and are described in detail.

Sell's Directory of Registered Telegraphic Addresses with Telephone Numbers and Classified Trades, 1931. London: Business Dictionaries, Ltd., 8 and 9, Johnson's-court, E.C. 4. Price 45s. net.—For many years past we have welcomed each new issue of "Sell's," and we are pleased to note that the forty-sixth edition maintains the high standard of its precursors. As heretofore, our experience with the new volume is that accurate information can be found with the minimum amount of effort.

A Test of an 850 B.H.P. Oil Engine.

In our issue of February 7th last year we gave a full technical description of an 850 B.H.P. enclosed type vertical airless injection six-cylinder oil engine made by Ruston and Hornsby, Ltd., of Lincoln, and we append here the report of some tests carried out upon this engine by Mr. W. A. Tookey, M.I. Mech. E.:—

The engine was built two years ago at Lincoln, where it underwent extensive bench tests before its transference to Grantham. It operated there on the normal works load as originally designed; that is to say, without supercharger, from October, 1929, to June, 1930, when it was converted to operate as a supercharged engine on the Buchi system. Experimental tests having been made in July and August, 1930, it has since been in regular service on the works load from August 19th, 1930, to the present date. The original rated output of the engine was 850 B.H.P.—142·5 B.H.P. per cylinder—at 250 r.p.m., equivalent to 72 lb. brake mean effective pressure. The normal output with supercharger is 1200 B.H.P.—200 B.H.P. per cylinder—at 250 r.p.m., equivalent to 102 lb. brake mean effective pressure. The engine operates on the four-stroke cycle; cylinder dimensions, 18½in. bore, 24in. stroke; compression pressure, without supercharge, 370 lb. per square inch.

The engine was direct coupled to a Mather and Platt D.C. generator rated at 825 kW, 220/230 volts, 3585 ampères, which, when tested at the makers' works on July 21st, 1928, gave the following efficiencies:—

TABLE I.

	Overload, 25 per cent.	Full load.	Three-quarter load.	Half load.	Quarter load.
Ampères	4500	3600	2700	1800	900
Volts	229	229	229	229	229
kW output	1031	825	618·5	412·5	206
kW input	1084·6	866	650·2	436·8	225
Efficiency	95·2	95·3	94·9	94·5	91·7
With allowance for unmeas'd losses	93·8	93·9	93·5	93·1	90·3
Factor $\frac{\text{B.H.P.}}{\text{kW}}$	1·43	1·43	1·435	1·44	1·485

THE OBJECTS OF THE TEST.

A.—To determine the rate of fuel oil consumption per unit of electricity generated at full rated output and at fractional loads.

B.—To compare the results of "A" with the engine-room logs from August 19th, 1930, to January 31st, 1931.

C.—To scrutinise the logged rates of fuel oil consumption as used by the engine before it was fitted with the supercharger, March 10th to June 2nd, 1930, and to compare them with similar figures for the period August 19th, 1930, to January 31st, 1931, with supercharger.

D.—To measure the quantity of lubricating oil during the test and to compare the result with the quantity logged for the period mentioned under "B" as above.

METHODS OF MEASUREMENT.

The amount of electric current generated was measured by the switchboard instruments and throughout each test was recorded at five-minute intervals by (A) readings of voltmeter and ammeter; (B) readings of watt-hour meter. Intermediate readings of B were taken by signal at the commencement and termination of each oil consumption test, and at intervals of about fifteen minutes the number of turns of the rotor of the watt-hour meter during a uniform time interval was recorded as an additional check.

Graphs were drawn of both output and consumption as each trial proceeded, and thus constant supervision was exercised throughout.

In addition to the works load a series of water resistances was arranged so as to apply and control the necessary load variations.

The fuel oil used during the trial has been analysed and reported upon by Mr. R. H. Harry Stanger, of Westminster, as follows:—

Analysis.

	Per cent.
Hydrogen	11·30
Carbon	87·64
Sulphur	0·25
Oxygen, &c.	0·81
	100·00

Calorific Value.

Calories per pound	10,871
B.Th.U., gross	19,568
B.Th.U., net	18,400

The oil was supplied by the Anglo-American Oil Company and is grade "A" Diesel oil, with a specific gravity at 60 deg. Fah. of 0·878 and a viscosity (Redwood) at 100 deg. Fah. of 34 seconds.

The fuel oil was pumped into a receiving tank suspended from a spring balance and was transferred to the measuring tank in weighed quantities, the time between observations—averaging fifteen minutes—being noted by a stop watch when the receding oil level showed a broken surface around a submerged point.

A continual series of weighings against time was maintained so that the rate of fuel consumed could be plotted on a graph with output of electricity as mentioned above. Regular curves of both output and consumption were thus obtained and from these the mean rates per hour during each test were computed.

The exhaust temperature was observed from each of the six cylinders by a standard electrical resistance pyrometer made by the Cambridge Scientific Instrument Company, and the figures tabulated in this report are the mean of means for the various tests, excluding those noted during the period of temperature changes consequent upon load variations. The exhaust pressure at the inlet of the turbine was measured by a mercury manometer.

The temperature of the air leaving the exhaust driven supercharger to the engine manifold was noted at intervals coincident with fuel consumption observations and with the pressure of air as measured by a mercury manometer.

The variation of turbine speed as shown by tachometer consequent upon variation of load was observed and Fig. 1 shows its co-ordination with air and exhaust pressures. The engine speed was adjusted for each test and roughly set by tachometer, actual speeds being counted by hand.

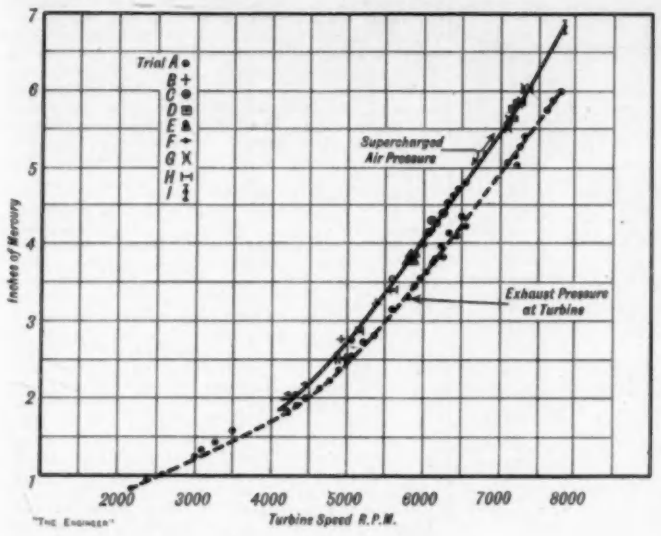


FIG. 1

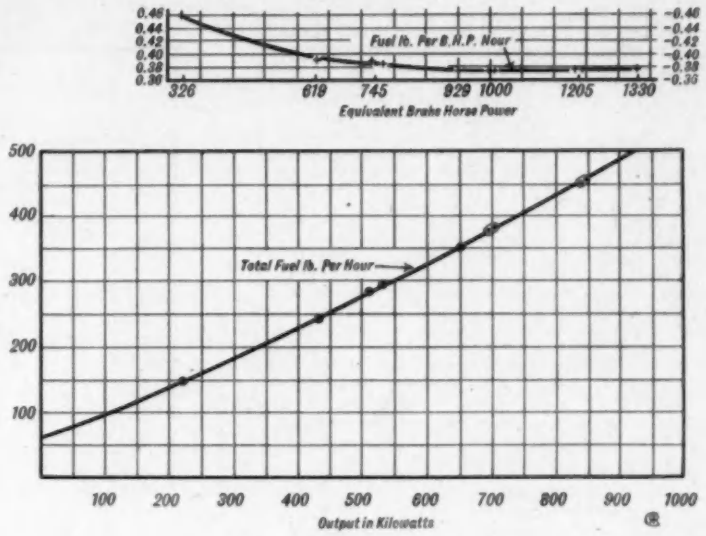


FIG. 2

SEQUENCE OF TESTS.

The sequence of the tests and the chief observations are tabulated in Table II. and a summary of the results is given in Table III.

The curves in Fig. 2 show the satisfactory co-ordination of all test results in terms of kilowatt output and oil fuel consumption in pounds per hour and also the equivalent in terms of B.H.P. per hour.

COMPARISON OF UNSUPERCHARGED AND SUPERCHARGED PERIOD OF WORK.

From the engine-room logs I have prepared the charts shown in Figs. 3 and 4, which represent graphically the daily output in kilowatts generated and the fuel oil consumption figures for the two periods after and before the supercharger was fitted. For the clearer appreciation of the comparative records the mean line of Fig. 3 from 3500 kW and 2000 lb. of fuel has been reproduced on Fig. 4. The curves are otherwise identical.

It will be noted that at the cluster of plotted points at 3500 kW and 2000 lb. of oil the actual rate of consumption under everday conditions of service was 0·57 lb. of oil per unit of electricity.

After conversion to supercharging the main cluster of points has been increased to 5500 kW and 3000 lb. of oil, equivalent to 0·546 lb. of oil per unit generated. Comparing this with the results of tests E and F, a close correspondence is indicated for the mean output of 610 kW with the unavoidable load variations consequent upon normal service conditions.

This rate of fuel consumption is extremely low and with oil fuel at 80s. per ton the cost for fuel only is 0·234d. per unit generated.

LUBRICATION.

From the engine-room logs I have summarised the rate of lubricating oil consumption as recorded daily from August 19th, 1930, until January 31st, 1931, both dates inclusive. During this period the engine was in operation 650 hours and generated 357,460 kW. The total amount of lubricating oil used for cylinders, valve cups bearings—including turbine and scavenger blower—was 2494 lb., or 3·84 lb. per hour. The specific gravity of the Shell 1408 oil is 0·934, so that the equivalent in gallons is 0·411 per engine hour.

Expressed in the units adopted in the Report on Working Costs published by the Diesel Engine Users' Association, the lubricating oil consumption for the engine now reported upon is at the rate of 1 gallon for 1340 units of electricity actually generated, or for 1925 brake horse-power hours, but had the engine been delivering its full power of 1200 B.H.P. the rate would then have been 1 gallon fo 2925 B.H.P. hours.

TABLE III.

Test.	Output. kW.	Output. B.H.P.	B.M.E.P.	Fuel consumption per hour. per kW.	Fuel consumption per hour. per B.H.P.	Thermal efficiency per B.H.P. Gross.	Thermal efficiency per B.H.P. Net.
						Per cent.	Per cent.
A	705	1008	81·5	0·541	0·378	34·4	36·5
B	512	732	60·5	0·555	0·388	33·5	35·6
C	700	1000	82·5	0·54	0·378	34·4	36·5
D	840	1200	98·3	0·538	0·377	34·5	36·6
E	650	929	74·9	0·538	0·377	34·5	36·6
F	430	619	50·9	0·562	0·391	33·2	35·3
G	846	1210	96·0	0·538	0·376	34·5	36·7
H	530	761	62·2	0·551	0·384	33·8	36·0
I	930	1330	109·5	0·537	0·376	34·5	36·7
J	221	326	26·0	0·677	0·459	28·3	30·1

TABLE II.

Test.	Duration. hours.	kW output.	Fuel, lb. per hour.	Exhaust. Temperature, deg. Cent.	Exhaust. Pressure, "HG.	Turbine speed.	Supercharged air. Pressure, "Hg.	Supercharged air. Temperature, deg. Fah.
A	2	705	381	308	3¾	6100	4¼	103
B	1	512	284	284	2½	5050	2¾	88
C	1	700	378	305	3¾	6100	4¼	104
D	1	840	452	330	5¼	7200	5¾	118
E	1	650	350	297	3½	5900	3⅞	101
F	1	430	242	262	1¾	4300	2	78
G	3	846	455	340	5¼	7240	5¾	125
H	1	530	292	298	2¾	5220	3	94
I	1	930	500	363	5¾	7620	6¼	140
J	1	221	149·5	200	1¼	3190	—	79
K	1	—	60	95	¾	2430	—	66

Conclusions.

As far as I am aware, this report is the first certified presentation of test and operating results over an extended period for supercharged heavy oil engines. The technical value of such co-ordinated comparison is very considerable, but the commercial and industrial significance of the operating results over several months before and after conversion to the Buchi supercharging system is certainly no less important.

The results obtained from previous test bed trials of two larger 2750 B.H.P. marine type oil engines with fuel injection by compressed air on the Diesel principle and fitted with a similar supercharger are in my possession, and when compared on the basis of mixture strength against brake mean effective pressure I find that the engine now reported upon gives equivalent ratios throughout. This indicates that the 1200 B.H.P. Ruston airless injection engine with supercharger is as economical as air injection engines of more than double its rated output.

During the trials the limit of power output was demonstrated as being due to the maximum fuel pump capacity having been reached. In my opinion, higher brake mean effective pressures could have been produced with safety and economy had it been possible to increase the amount of fuel injected at each cycle. The maximum output actually attained—1330 B.H.P.—was no less than 56·5 per cent. above the normal unsupercharged rating—850 B.H.P.

It is a remarkable feature of this series of tests that the extremely low rate of fuel oil consumption extends, with practically no variation, from 750 B.H.P. to the 1330 B.H.P., which, for the reason already stated, was the highest possible under the conditions obtaining. This is not only a testimony to good design, but to excellent workmanship. It will be noted that repeated tests at

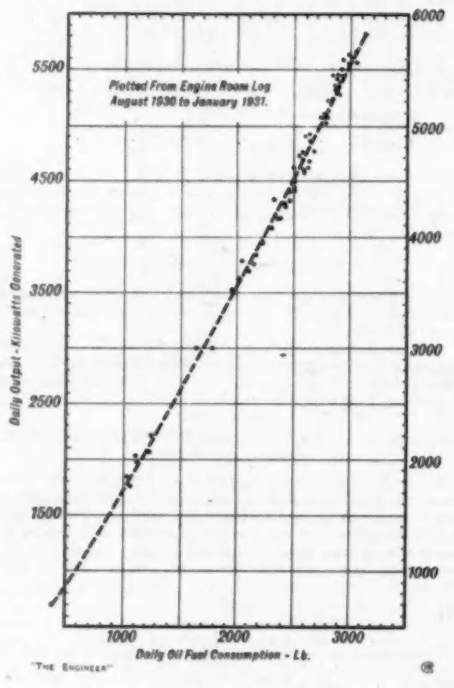


FIG. 3

similar loads at different periods gave uniform results, and this with entire absence of hand adjustment or "nursing."

The figure of 0·38 lb. of fuel oil per British B.H.P. hour—say, 170 grammes per metric H.P. hour—is fully comparable with the best continental practice.

The entries in the daily log of units of electricity generated and weight of fuel consumed provide ample proof that the observations made during the two days of my inspection are in substantial agreement with the power-house records extending over a considerable period. These records also testify that, apart from stoppages for routine inspection, &c., the set has been operating continually nine hours per day. Any doubt as to the reliability and robustness of the exhaust-driven turbo-blower is thus set at rest. From Fig. 3 accompanying this report it is clear that the engine has at some periods of the day been called upon to develop considerably more than the 75 per cent. of its supercharged rating which the average daily output denotes.

Table IV. has been prepared to indicate the rate of fuel oil consumption represented by the curve plotted through the dotted points in Fig. 3.

Table IV.

Output, kW per diem.	Consumption, lb. per diem.	Fuel oil, lb./kW/hour.
2000	1160	0·58
2500	1450	0·58
3000	1700	0·57
3500	2000	0·57
4000	2250	0·56
4500	2500	0·56
5000	2750	0·55
5500	2950	0·54

Such regularity of daily performance over a period of five months is very striking and shows that marked economy in operation has in fact been maintained over an extremely wide range of output variation.

The low lubricating oil consumption is indicative of careful planning of distribution, cooling and filtering systems. The observed rate of consumption for all purposes during the trials G to K inclusive was 20 lb. 3 oz. in 9½ hours, or, say, 0·2275 gallon per engine hour. As mentioned above in this report, the mean rate over the period August, 1930, to January, 1931, was 0·411 gallon per engine hour. At the rated output—1200 B.H.P.—these figures are equivalent to 0·0019 and 0·0034 gallon per B.H.P. hour respectively, differences which, in my experience, are in accord with short "test" and long "normal operating" observations. There is no doubt that the economical use of lubricating oil is coincident with low consumption rates of fuel oil.

Throughout the whole series of trials there was an entire absence of vibration and undue noise, and at no time was there sign of faulty combustion in the colour of the exhaust gases.

I was impressed with the relatively small space which was occupied by the combination of 1200 B.H.P. engine and 825-kW generator and the arrangement of exhaust pipe connections to the supercharging turbo-blower was

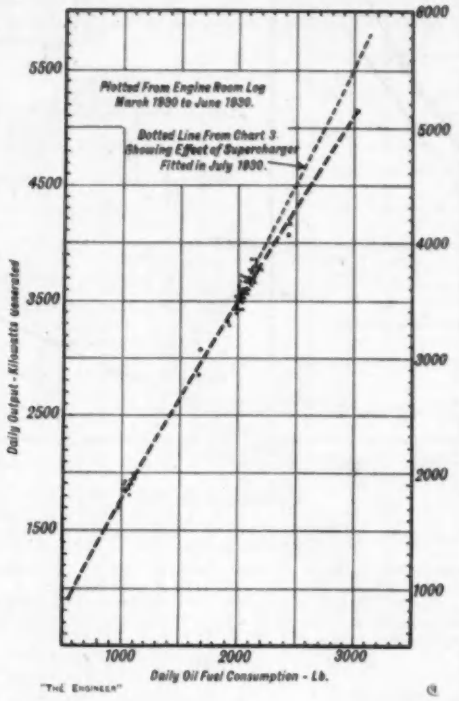


FIG. 4

much simpler than any I have yet inspected. The suitability of such combinations for stationary and marine installations is very apparent.

The Measurement of Noise.

The measurement of noise was the subject of a discourse given at the Royal Institution on Friday evening, May 8th, by Dr. G. W. C. Kaye, Superintendent of the Physics Department, National Physical Laboratory.

The popular conception of noise as an acoustical annoyance, or redundance, is as good a definition as any, though in Shakespeare's time the term was used to signify an agreeable or melodious sound. In more recent times, "noise money" was a recognised payment at sea for crews while manipulating fog signals.

Reaction to noise is largely temperamental, and, to some extent, is conditioned by environment. Herbert Spencer used to plug his ears with cotton wool and declared that intolerance of unnecessary noise was bound up with intellectual capacity! O. Henry, on the other hand, protested that the silence of the country was such that he could not sleep owing to the noise of the grass blades sharpening themselves against each other. Many people are partial to mixed musical noises, particularly in their lighter moments, though there are those who seek to associate a liking for jazz with immaturity, arrested development, or even worse! Noise is clearly a subjective phenomenon, and we ought not, therefore, to be surprised to find that "one man's noise is another man's music."

The findings of the New York Noise Abatement Commission supported medical testimony in this country that, while most individuals, particularly the hale and hearty, can accustom themselves to living or working in a noisy environment, there can be little doubt that, in general, noise has a harmful effect, even on those who are to all appearances immune. The evil is emphasised in the case of mental workers, young children, the nervous, the fatigued, and the sick.

People instinctively compare noises with one another, and no doubt the well-known fact that listening to music engenders in some persons an unquenchable desire to converse is associated with the rough-and-ready test which we automatically apply to a noise; that is, whether or not we can hear one another speak. Conversation at once languishes in a tube train or aeroplane cabin.

The "yardstick," or "degree," by which we measure noise, is the decibel, a simple power-ratio or logarithmic unit, whose adoption hinges on the fact that, while the sensation of loudness in the ear advances, the energy corresponding increases geometrically by leaps and bounds on a scale which extends over almost astronomical magnitudes. The decibel scale is a rough fit with the aural scale of loudness sensation. Moreover, the decibel has the further advantage of corresponding approximately to the least perceptible change in loudness of a sound of medium loudness under average conditions. The complete range of auditory loudness is covered by about 130 decibels, from the very softest sound to one so loud that it pains the ear.

The majority of people seem to find high-pitched notes more offensive than low, particularly when they are loud. The high-pitched motor horn, to the staccato use of which the Paris taxi-driver is so addicted, is more irritating to the majority than the lower-pitched horn which normally obtains in this country.

The amount of energy in most sounds of everyday experience is extremely small. A Final Cup-Tie crowd of 100,000 at Wembley Stadium all talking continuously and rather loudly would provide as much speech power as would, if converted, light a small electric lamp throughout the game. Alternatively, by the end of the match, the acoustical energy expended would have been sufficient if transformed into heat to make one cup of tea.

Although the measurement of noise is one of some complexity, being bound up in part with physiology and psychology, the physics of acoustical measurement has made great strides both in facility and exactitude. This is largely owing to the development of electrical methods based on the invention of the electronic valve. By such means noises can be analysed into spectra showing their frequency components, and their loudness can be measured physically by the microphone. Alternatively, they can be compared aurally with some calibrated source of loudness, for example, an electric buzzer, a valve-oscillator note, a "warbling" gramophone record, or a tuning fork.

A convenient "noise thermometer" ranges from 0 to 100 decibels—an upper level, which is unlikely to be exceeded in everyday experience. Conversational level is at about the half-way point—50 db. The value for a quiet suburban street is 30 db., for a tube train 80 db. Twins crying together are only 3 decibels louder than one crying solo!

Loudness levels of everyday noises have been determined by the National Physical Laboratory in this country and by the Bell Telephone Laboratories and others in the States. New York traffic noises, both in the street and in the Underground, appear to be about 10 decibels louder than in London. A modern car is quieter than a horse vehicle on a paved street. The National Physical Laboratory conducted measurements on motor horns for the Ministry of Transport, and arrived at general conclusions as to stridency which are on all fours with the recent findings of the New York Commission.

Among the loudest things one is likely to encounter are the noises of riveting, pneumatic road drilling, steamship sirens and printing presses. More untoward encounters are lions and the Niagara Falls, which can, apparently, roar equally loudly (85 db.). But the arch offender of all is the aeroplane engine at close quarters (110 db.). The noise in the cabins of aeroplanes in flight ranges between 80 db. and 110 db., according to the type of machine. There are, however, good prospects that the noise in aeroplane cabins will presently be substantially reduced—possibly to that of a railway train—by using propellers with lower tip speeds, providing more effective silencers on the exhausts, reducing engine clatter by enclosing the engines, and constructing cabins of double walls containing a suitable filler.

So far, in this country, the menace of the public loud-speaker has not attained the dimensions which it has reached in America. Giant sound amplifiers now make it possible to hear the human voice nearly two miles away, and we learn that last Christmas carols were broadcast by this means for 10 hours over an area of some 9 square miles. The centre of this acoustical disturbance was the 81st floor of the Empire State Building—the latest and highest—1250ft.—skyscraper in New York.

The question of protection from noise is being investigated at the National Physical Laboratory, and new sound laboratories are to be erected in the near future.

Some Difficulties of A.C. Bridge Measurements.

At a recent informal meeting of the Institution of Electrical Engineers, Dr. A. Rosen opened a discussion on "Some Difficulties of A.C. Bridge Measurements." A.C. bridges, Dr. Rosen explained, were of interest to all connected with the weak current side of the electrical industry, namely, telegraphy, telephony, wireless and the newer recruit, television. They were also used by those who dealt with such sections of the heavy current side as power cables, transformers and switchgear. His object was not primarily to discuss the merits or demerits of particular forms of bridge networks, but rather to direct attention to some of the difficulties and sources of error which were encountered.

Many descriptions of A.C. bridges consisted of a diagram and a formula. The components were connected up according to the diagram and from the reading of the balance obtained the result was worked out by means of the formula. The connections might be quite correct, the balance carefully taken and the calculation might be beyond reproach, yet the answer could be hopelessly wrong, owing to the numerous factors of error that might arise. One of the difficulties which formerly limited the range of A.C. bridge measurements was the unsteadiness in frequency of the current source. In using a machine to supply the current, work with a bridge in which the balance varied with the frequency was a tedious and tricky job, and a number of systems had been devised to regulate the speed automatically. The introduction of the valve oscillator had revolutionised A.C. bridge measurements. Its steadiness, flexibility, and wide range of frequency had improved old methods and made new ones possible, particularly those methods in which frequency entered into the balance. The valve generator was capable of still further improvement, and English manufacturers should produce an oscillator in which the frequency was independent of load and of the voltages of the filament and plate batteries, with a pure wave form, and in which the output was continuously variable over the whole of its range.

Valves used as amplifiers in the detector circuit could increase the sensitivity a hundredfold, but in doing so they might magnify the errors, so that special care had to be taken in their use. In some cases increased sensitivity permitted measurements to be made on smaller quantities, *e.g.*, in finding the power factor of dielectrics, and it was an advantage to be able to obtain a reliable figure on a small sample of the material. One of the most fruitful causes of trouble was the induction of spurious currents in the receiver, which might be due either to direct pick-up from

the source or components of the bridge or to potential differences existing between the windings and the body of the detector. Spurious currents due to direct pick-up could be observed by disconnecting the detector from the bridge and noting if there was any sound in the telephone. They could be avoided by keeping the detector at a distance from all sources of external fields. Methods had been devised whereby the effects of the earth capacitances were eliminated without losing the simplicity of balance of the original bridge network and without restricting the potential of the unknown arm with regard to earth. They employed a system of multiple screens in which one screen was completely enclosed within another. Special care was needed with adjustable resistances, as the combination might have an appreciable phase angle, although the individual coils were non-reactive. Another difficulty was that the phase angle varied with the number of coils in circuit. The variation of phase angle could be overcome by providing each decade with its own shield and by correctly arranging the shields, but in doing so the phase angle was increased. It was a choice between a small variable-phase angle and a larger fixed one, and for precise work the second alternative was preferable.

In general, it was an advantage to use a bridge in which there were two adjacent equal arms, *e.g.*, fixed resistances. In this case it was not necessary for the resistances to be non-reactive, providing they had the same time constant. Further, inequalities could be detected and allowed for by interchanging the ratio arms and taking the mean of the two sets of readings. Many causes of error could be eliminated by the substitution method, using a dummy balance. The bridge was first balanced with the unknown in position; the unknown then being replaced by a suitable variable impedance. Provided that the conditions had not been altered by the substitution, that gave very accurate results and, furthermore, was independent of any errors in the other arms of the bridge. It was important to ensure that the conditions existing at the time of measurement on a piece of apparatus were the same as the conditions when the apparatus was in use. For example, in measuring the inductance of an intervalve transformer, the correct value of direct current should be superimposed on the alternating current through the primary. Similarly, in measuring the capacitance of a condenser, the potentials of the terminals should be correctly related to each other and to earth. Those potentials were determined by the capacitances of the terminals to each other and to earth.

The following members took part in the subsequent discussion:—Messrs. H. Abrahams, L. S. Crutch, D. J. Fee, M. J. Gartside, J. L. Greatorex, Q. L. Lay, R. Mines, A. T. Moore, E. Rushton, G. H. Sammons, and J. F. Shipley.

LAUNCHES AND TRIAL TRIPS.

ASHMORE, single-screw motorship; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd., to the order of Skiba A/S. "Ashmore"; dimensions, 408ft. by 54ft. 9in.; to carry oil in bulk. Oil engines, Armstrong-Sulzer type; constructed by the builders; trial trip, April 14th.

CAMAGUEY, steamship; built by Earle's Shipbuilding and Engineering Company, Ltd.; to the order of the Empresa Naviera de Cuba, Havana, Cuba; dimensions, 240ft. by 37ft. by 14ft. 6in.; to carry cargo. Engines, triple-expansion, 18in., 30in., and 50in., by 36in. stroke; constructed by the builders; trial trip, April 16th.

RANGATIRA, twin-screw turbo-electric driven ship; built by Vickers-Armstrongs, Ltd., Barrow-in-Furness; to the order of Union Steamship Company of New Zealand, Ltd.; dimensions, 400ft. by 58ft. by 29ft.; to carry passengers. Engines, turbo-alternators and propelling motors constructed by British Thomson-Houston Company, Ltd.; launch, April 16th.

HILARY, single-screw steamer; built by Cammell Laird and Co., Ltd.; to the order of Booth Steamship Company, Ltd., of Liverpool; dimensions, 420ft. by 56ft. by 37ft.; to carry passengers and cargo. Engines, triple-expansion, 29in., 48½in., and 81½in. by 57in. stroke, pressure 230 lb. per square inch; constructed by the builders; launch, April 17th.

SAN PEDRO, steamship; built by Harland and Wolff, Ltd., Belfast; to the order of Compagnie Générale Transatlantique; dimensions, 430ft. by 57ft. by 37ft. 6in.; to carry cargo. Engines, four-cylinder triple-expansion, 31in., 50in., 60in. and 60in. by 60in. stroke, pressure 205 lb. per square inch; constructed by the builders; this ship is the last of six which Harland and Wolff, Ltd., have constructed; left Belfast, April 17th.

BRITISH STRENGTH, motor vessel; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of British Tanker Company, Ltd.; dimensions, 456ft. by 59ft. 3in. by 38ft.; to carry oil in bulk. Oil engines, Doxford opposed-piston type; constructed by Richardsons, Westgarth and Co., Ltd.; trial trip, April 28th.

THREE STEAM TUGS; built by Richard Dunston, Ltd., Thorne, near Doncaster, to the order of the London and North-Eastern Railway Company, for service at Grimsby and the river Humber; dimensions, 65ft. by 14ft. by 8ft. Engines, compound surface condensing; constructed by Plenty and Son, Ltd.; these tugs were launched sideways; launch, April 28th.

MOYRA, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Inter-Provincial Steamship Lines, Ltd.; dimensions, 257ft. by 39ft. 6in. by 24ft. 4in.; to carry cargo. Engines, triple-expansion; constructed by the builders; launch, May 2nd.

TAJANDOEN, single-screw motor vessel; built by Netherland Shipbuilding Company, Ltd., to the order of Messrs. N. V. Stoomvaart Maatschappij "Nederland;" dimensions, 490ft. 1in. by 62ft. 2¾in. by 36ft. 5in.; to carry cargo. Oil engines, Sulzer type; constructed by Werkspoor, Ltd.; launch, May 2nd.

PAN SCANDIA, single-screw motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of A/S. Astrea; dimensions, 490ft. by 67ft. by 37ft. 3in.; to carry oil in bulk. Oil engines, Wallsend-Sulzer type; constructed by Wallsend Slipway and Engineering Company, Ltd.; launch, May 4th.

KARABAGH, motor vessel; built by Blythswood Shipbuilding Company, Ltd., to the order of Baltic Trading Cor pany, Ltd.; dimensions, 425ft. by 57ft. by 32ft.; to carry oil in bulk. Oil engines, Burmeister and Wain type; constructed by John G. Kincaid and Co., Ltd.; launch, May 5th.

GARTBRATTAN, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of Gart Line, Ltd.; dimensions, 275ft. by 42ft. by 27ft. 6in.; to carry cargo. Engines, triple-expansion, 19in., 32in. and 54in. by 36in. stroke, pressure 200 lb. per square inch; constructed by the builders; launch, May 6th.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

DEPRESSION persists in the heavy industries in the Midlands and Staffordshire, the past week having provided nothing in the shape of alleviation. Demand for iron and steel continues poor. Most of the engineering firms are quiet and the outlook is uncertain. Activity is restricted in all departments and material purchases are confined to tonnages just sufficient to enable users to carry on without interruption. There are practically no stocks at the consuming works. Inquiries are still coming in and encourage hopes of improved buying in the near future. Hopes have been dashed so often of late, however, that industrialists now adopt a cautious attitude and decline to act upon possibilities.

Raw Iron.

Midland blast-furnacemen continue to produce at a steady pace and are able for the most part to dispose of the iron made, though were they to rely entirely upon district consumers they would possibly find themselves with a considerable surplus to add to their stocks. Especially is this the case with Northamptonshire smelters, who are not generally associated with pipe foundries, as are their Derbyshire fellows. Fortunately, for the Northamptonshire furnacemen, they are able to sell some of their make outside the prescribed area in which prices are controlled, and by selling fair quantities at cheaper rates in other districts they are thus keeping down stocks. In this district pig iron business is confined chiefly to small tonnages for early delivery, with a few isolated exceptions, in which foundries are comparatively better off and are ordering on a somewhat heavier scale. There are a few Black Country foundries which are reported to be ready to increase their specifications slightly. To balance this, however, there are a number which report that they have sufficient iron for current consumption, and they are not prepared to budget ahead. They assert that the price they are asked to pay is too high, and as there appears to be little likelihood of makers being in a position to advance quotations in the near future, there is nothing to be gained by putting iron into stock, especially as almost immediate delivery can be obtained if unforeseen requirements arise. Generally speaking, demand for foundry iron is poor, though regular, and the market this week has shown no new activity. In the forge department business is almost stagnant. Local consuming works are, in many cases, in a pitiable position, while in others work is, at best, irregular and very much below normal in volume. All pig iron quotations are upheld at the Association's minimum level. Derbyshire and North Staffordshire No. 3 foundry is quoted £3 11s., forge £3 6s., Northamptonshire foundry £3 7s. 6d., with forge £3 2s. 6d., for delivery in the Black Country.

Steel.

The market for finished steel is no better than it has been in recent weeks and depressed conditions rule in all the heavy branches. Midland constructional engineers are, generally speaking, very short of contracts, though here and there are to be found more favourably placed firms. Competition for the work available is keen and resultant profits are small. Prices are upheld, but were it not for the fact that they are controlled by the manufacturers' association, it is very probable that they would have fallen ere this. In the uncontrolled department of the steel trade makers are unable to withstand the pressure brought to bear upon them by consumers, and values continue in a downward direction. Local re-rollers have this week accepted as low as £6 17s. 6d. for bars re-rolled from continental billets and £7 5s. for all-British small bars. These figures are about half-a-crown below recently accepted levels. Mild steel billets of local manufacture are quoted from £5 5s. upwards. Boiler plates are now more generally quoted £9, few firms asking the additional half-a-crown they required a week or so ago. Staffordshire hoops command £9 10s. at makers' works. Sellers of continental material are again cutting prices. 2in. billets being offered at £4 10s. delivered, and steel bars at £4 17s. 6d. Belgian No. 3 iron is named at £4 17s. Merchants generally report poor business.

Staffordshire Iron.

Staffordshire ironmasters experience considerable difficulty in securing orders, and are unable to keep mills rolling regularly. Even in the best bar branch of the trade business is dull, demand having fallen away somewhat during recent weeks, and this despite the fact that ironmasters recently reduced selling prices. If they had hoped to stimulate demand, they must have been disappointed. Crown bar sales show no improvement, and neither local ironmasters nor competitors from other districts are able to dispose of a reasonable amount of material. Stagnation characterises the common bar branch of the Staffordshire iron trade. The nut and bolt, fencing, and other consuming industries are quiet, and there is little opportunity even at the best of times of making sales against the foreigner. Iron prices are unchanged. Marked bars make £12 per ton, Crown quality £9 10s. upwards, nut and bolt bars £8 12s. 6d., and iron tube strip £10 17s. 6d. per ton.

Galvanised Sheets.

Manufacture of galvanised sheets in the Midland area is of a restricted character, most mills producing much below capacity. There has been no change in the state of trade during the past week, and there is little evidence of recent inquiries from overseas markets having matured. It is, however, hoped that business will result from many of the inquiries which have been in circulation and from others which are now coming to hand. Mill owners see no reason at the moment to interfere with existing quotations, which are based on £11 per ton f.o.b. for 24-gauge galvanised corrugated sheets. The automobile industry is taking delivery of slightly larger tonnages of black sheets, but the demand so far this season has proved disappointing. Values in this department also show no change.

Prince's Midland Industrial Tour.

The Prince of Wales on Monday spent a busy day visiting Midland works and factories. This industrial tour was to enable him to see the factories at work under ordinary conditions, and for that reason no preliminary announcement was made as to the works which had been selected for inspection. At the Wellington Tube Works, Great Bridge, the processes employed in the manufacture and testing of 1in. bore wrought iron tubes from Staffordshire puddled iron, which are used for the conveyance of gas, steam and water, occupied the attention of the Prince for some 20 minutes, and he also witnessed the hand-forging of fittings. At the works of the Birmingham Railway Wagon and Carriage Company, Ltd., on the borders of Smethick and Handsworth, all the processes that go to the manufacture of railway wagons and coaches, from body-building to upholstering and varnishing, were inspected, and among the completed products of the firm which were viewed with more than ordinary interest was a covered goods wagon made entirely of steel and with a capacity of 40 tons—one of a number being made at the works for the Buenos Aires and Pacific Railway Company. The Metropolitan-Cammell Carriage and Wagon Company's works, Washwood Heath, were also visited. There he saw completed all-steel carriages for the Underground Railway and for railways in Cordoba, the Argentine and the Gold Coast. Steel bodies for motor omnibuses were also examined in process of manufacture. At the Bromford Tube Company's works, Erdington, the Prince saw a steel billet withdrawn from a furnace, put through a piercing mill, and then rolled out into a tube. His Royal Highness also visited Fort Dunlop, the works of George Salter and Co., Ltd., spring and spring balance manufacturers, West Bromwich; C. H. Collins and Sons, Ltd., imitation jewellery manufacturers, and Wright and Hadgkiss, jewellery manufacturers, both of Birmingham.

£48,000 Bridge Contract.

It is anticipated that Warrington Town Council will accept the tender of Bolton and Lakin, Ltd., of Birmingham, of £48,375, for the construction of a ferro-concrete bridge crossing the Mersey. Two arches, each with a span of 86ft., are provided for in the design of the bridge. The road will be 60ft. wide between the parapet walls, and there will be two footpaths, each 12ft. wide. It is expected that the construction will take about twenty months.

Rail Motors Order.

The General Electric Company, Ltd., Witton Works, Birmingham, has received from the London Underground Electric Railways Company, further orders to a total of 372 heavy railway motors similar in type to those already supplied.

Steam Rail Cars.

The Sentinel Waggon Works, Ltd., of Shrewsbury, has received through the Crown Agents for the Colonies, an order of a value of approximately £35,000 for five "Sentinel-Cammell" standard type 100 H.P. double-articulated steam rail cars for service on the Federated Malay State railways.

Unemployment Decrease.

The latest statistics record that the number of persons on the registers of employment exchanges in the Midlands Division was 244,379 wholly unemployed, 114,187 temporarily stopped, and 516 normally in casual employment, making a total of 359,082. This was 6767 less than a week before, and 122,835 more than a year before. The total comprised 243,508 men, 8491 boys, 98,295 women and 8788 girls. The Birmingham figures are up on the week, the total having risen from 64,132 to 65,174. At Stoke-on-Trent, Leicester and Nottingham and Walsall also the totals have risen, but those at Coventry and Wolverhampton are slightly lower.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

New Electrified Line in Operation.

AFTER operating under steam for a little over eighty years, the Manchester, South Junction, and Altrincham line, jointly controlled by the London, Midland and Scottish Railway Company and the London and North-Eastern Company, which has been electrified at a cost of about £500,000, after constructional work extending over 2½ years, was put into official operation on Monday of this week. Trial runs had been carried out successfully for some time, but the opening day, under normal conditions of passenger traffic on what is probably the busiest suburban line running out of Manchester, did not pass without interruptions, due to technical difficulties which were soon rectified. A hitch also occurred with one of the early morning trains entering Manchester on Tuesday, and a certain amount of traffic delay was inevitable. Worries of this nature were not altogether unexpected, however, having in mind the fact that the transformation from steam to electricity was made in one move and not gradually, and the confident official view is that smooth running to schedule times is a matter only of days. A full description of the Altrincham electrified line is given elsewhere in our present issue.

Engineers' Wages.

Mr. W. H. Hutchinson, the President of the Amalgamated Engineering Union and the chairman of the trades unions' negotiating committee, addressed a large meeting of employees' representatives at Oldham on

Sunday, and explained the position arising out of the negotiations with the employers on wages and hours of labour and the deadlock that has resulted. Mr. Hutchinson added little to what is already common knowledge, and eventually a resolution was carried, endorsing the decision of the negotiating committee in refusing the proposed conditions of the employers, and requesting the executives of the unions "to make it clear to the employers that if the proposed conditions are put into operation, all agreements, including the York memorandum, are cancelled."

The Market in China.

Some reference to the possible development of China as a market for British heavy machinery is contained in the report of the Manchester Association of Importers and Exporters for the year ended February last. The point is stressed that in engineering products, especially heavy machinery, no effective competition will be found in Chinese workshops for decades ahead. German and continental competitors will have advantages in price, but, it is urged, British machinery has established itself for quality and salesmanship should be able to impress upon the Chinese buyers the inherent superiority of the British article. The comments of the Association on this matter conclude with an exhortation to engineers in this country to be alive to the fact that the machine age has begun in China, and that much of the large sum that has been received from the Boxer Indemnity Funds will be spent on the purchase of machinery.

Craven's and Herbert Morris.

It is officially announced that in order to facilitate the development of their machine tool business and to obtain the necessary increased shop capacity, Craven Brothers (Manchester), Ltd., of Reddish, Stockport, has disposed of the crane section of its business, including goodwill, patents, patterns, and designs, to Herbert Morris, Ltd., of Loughborough, which firm will continue to manufacture the "Craven" cranes under the style of "Herbert Morris, Ltd. (Craven Brothers Crane Division)." Some of the technical staff of Craven Brothers will, it is expected, join the staff of Herbert Morris, Ltd.

Industrial Results.

Most of the dividend announcements issued by Lancashire engineering concerns during the past few days record low distributions, and, presumably, smaller profits, although at the moment of writing the latter has not been disclosed. In the case of Tweedales and Smalley (1920), Ltd., of Castleton, near Rochdale, manufacturers of textile machinery, the dividend on the ordinary shares for the year to the end of April last has been reduced to 7½ per cent., compared with 10 per cent. for the previous year; whilst Asa Lees and Co., Ltd., Oldham, another firm of textile machinists, is paying 5 per cent. for the twelve months ending March, against 7½ per cent. in 1929–30. Richard Johnson and Nephew, Ltd., wire manufacturers, of Bradford, Manchester, has announced an ordinary dividend of 5 per cent. for the year ending March, compared with 8 per cent. in the previous year. The directors of the Chloride Electrical Storage Company, Ltd., battery manufacturers, of Clifton Junction, Manchester, has declared a final dividend of 10 per cent. on the ordinary shares, making a total of 15 per cent. for the past year, against 30 per cent. for the preceding twelve months. It has to be explained, however, that the ordinary capital was doubled a year ago by the issue of a 100 per cent. share bonus, so that, in effect, the distribution is the same as before.

Non-ferrous Metals.

The non-ferrous metals market has passed through another trying week, with downward movements in evidence in all sections, although at the moment of writing compared with a week ago the position is better in respect of tin, which is 5s. to 10s. higher on balance, whilst in the case of spelter and lead the price pendulum has swung from the lowest point leaving values much the same as at last report. Increasing stocks of tin and speculative selling of the metal depressed prices to below what they had been for about thirty years. Talk of further reducing production has, however, since exercised a "bullish" influence, and, as already stated, a slight recovery has been recorded. Meanwhile, consumers are operating cautiously, and the demand during the past week has been poor. Copper is about 5s. cheaper than it was a week ago and buying interest is no better than before. Here, again, one has to go back to between thirty and forty years to discover equally low prices. After a certain amount of fluctuation, both spelter and lead have come back to the levels current at last report, but in neither case has the demand shown any improvement.

Iron and Steel.

Slow buying of foundry iron has been reported generally, and the view is that the position of the consuming industries in Lancashire is rather worse than what it was three or four months ago. Certainly, users have placed only very moderate orders, and in no recorded instance has buying extended much beyond the current month. Derbyshire, Staffordshire, and Cleveland iron for delivery equal to Manchester are all quoted at 69s. 6d. per ton, with Northampton at 68s., Scotch at about 88s. 6d., and West Coast hematite at 82s. 6d. In steel, the demand for heavy varieties, as well as high-carbon and special alloy steels is poor, and there is no disposition among users to enter into forward contracts, constructional, locomotive building, boilermaking, and pretty well every description of steel moving only in limited quantitites for virtually prompt delivery. Acid and basic boiler plates are no better than about £8 17s. 6d. to £9 per ton, according to quantity, with small re-rolled bars at about £6 15s.; general plates are at the controlled price of £8 17s. 6d. per ton, joists at £8 15s., sections at £8 7s. 6d., and large bars at £9 7s. 6d. A further shading in prices of imported iron and steel materials, both semi-finished and finished products, has occurred, but Lancashire users are showing little response to the extremely low levels now ruling in this section of the market.

BARROW-IN-FURNESS.

Hematite.

There is a distinct flatness in the hematite pig iron market, and the outlook is not bright. There was a time when the output from the district was being consumed, and when the heavy stocks were being reduced, but the fact that the steel departments in Workington and Barrow helped in that clearance rendered the position bad when the steel contracts thinned off and the local demand ceased. This is the case to-day. The requirements on steel account are dwindling, and at the same time the demands of customers for iron are not as heavy, and this either means increase of stocks or reduction of output. With stocks at over 100,000 tons, it would not be wise to increase them to any marked extent, hence restriction seems the only way unless trade improves. The signs to-day do not point in that direction. The amount of business with the Midlands is heaviest. Scotch and Welsh orders are low at present. Continental business is not strong; and American prospects are poor in view of the general state of things in the United States. The native iron ore trade is very quiet, and there is a further chance of it shrinking. Foreign ore is in quiet demand, and likely to be. The steel trade is down, and although Barrow restarted on a small contract there were no further orders to keep things going. Contracts at Workington are being worked out, and there seems little to come at the moment. Shipping is dull and many large cargo steamers are lying up in Barrow docks.

SHEFFIELD.

(From our own Correspondent.)

Steel Production Still Declining.

It has often been pointed out that Sheffield is usually the last of the steel centres of the country to feel the effects of improving trade, and, to judge from the latest figures available, it also seems to hold that unenviable position with regard to falling business. At any rate, it was the only centre of steel production which, during March, recorded a lower output than that of February, although March has more working days than the earlier month. The output in this area in March was 69,500 tons, as compared with 83,000 tons in February, and 112,000 tons in March of 1930—a falling off of nearly 40 per cent. on the year. In North Lincolnshire, the February level was rather improved upon, but the decline, as compared with twelve months ago, was even more serious, the respective figures being: March, 1931, 36,500 tons; February, 1931, 34,800 tons; March, 1930, 76,600 tons. Lincolnshire also produced 40,300 tons of pig iron, compared with 36,300 tons in February, and 77,900 tons in March last year.

Position at the Works.

There is not much change to report on the week in the condition of the local trades. While slight gains may be found in one or two departments, they are balanced by losses in others. Open-hearth production is still on a small scale—in fact, since my last letter, one furnace in the Rotherham area has been closed—and the orders coming in are so restricted, and so lacking in bulk, that plants have no assurance of continued operation for more than a week or two ahead. The scrap market is very quiet, and deliveries are meagre in the extreme, but no further decline of prices is reported. The demand for pig iron continues poor, although there is a slightly better inquiry for foundry material. There have been further deliveries of Indian pig iron at British ports. Shipbuilding and railway work, which normally consumes a large proportion of the open-hearth steel production, is at a low ebb. This applies particularly to shipbuilding, and local steel makers say that they cannot remember a time when the needs of that industry were so small. The reduced traffics on the railways are having their natural effect of lessened wear and tear, with the result that orders for axles, tires and springs are much below the level of a year ago, although that was not high. There will be an improvement in this department when the orders under the Chinese Boxer indemnity allocation are placed.

The Lighter Side.

There is a good deal of activity in the departments producing stainless steel and kindred materials, but no expansion has been recorded of late. The automobile builders are taking fair quantities of forgings, pressings and special steel for wearing parts, and the demands of the electrical engineering industry are very helpful. Steel for engineering and mechanical use, as well as ready-made tools, are selling moderately well in the home market. At the same time, the extension of the practice of using tipped tools for lathe and machine work is reducing the volume of demand for best quality tool steels. The most serious feature of the situation, however, is the great lack of overseas orders for special and tool steels. The effect of this is felt severely all through the city, even by some of the leading firms which have, in the past, done a large business with foreign countries. The quantity of ferro-alloys going into the works is greatly reduced, deliveries under contract having been heavily in arrear for some months past. There is hardly any forward buying, and, owing to the unloading of stocks on the market, prices have suffered, and are greatly in favour of buyers. There is a fair demand for the low-carbon ferro-chrome used in the production of stainless steels, but none of the other numerous alloys attracts much attention. Economies are still being carried out in all branches of local industry, and are resulting both in considerable cuts in wages and salaries and in numerous dismissals of workpeople and administrative staffs.

New Method of Rust Prevention.

A process of rust prevention which is said to represent a great advance on other methods in use is the Parkerizing process, which has recently been taken up by Stainless Plating, Ltd., of Brown-street, Sheffield. It is applicable to all kinds of ferrous metals, and is a low-temperature chemical bath process, which changes the surface of iron and steel and makes it proof against rust to a very high degree. No electrical deposition of one metal upon the material treated is required. The conversion is effected without any appreciable change of dimension, contour, or physical properties of the treated material, and the rust-proofing penetrates into the smallest crevice, treating the inside of small diameter tubes as effectively as the outside. As the process is exceedingly cheap, it can be applied to the cheapest iron and steel articles. It has been adopted by the leading motor car manufacturers, and is being found especially suitable for nuts, bolts and similar articles.

A New Industry.

An addition is to be made to Sheffield's industries by the manufacture of a new writing machine, known as the Invicta writer, for typing cheques and warrants. A demonstration of it was given before the Lord Mayor last Saturday, and it is intended to start manufacture of the machines this month, and delivery in about four months. The invention is entirely British, and is the result of more than ten years' experiment.

Lincolnshire Water Schemes.

A Ministry of Health inquiry has been held at Mablethorpe with regard to a scheme of the Mablethorpe and Sutton-on-Sea Urban Council for providing a public water supply for Mablethorpe and Trusthorpe, at an estimated cost of £26,540. The proposal is to obtain water from Maltby-le-Marsh, and convey it to a water tower at Mablethorpe, 3 miles distant. The supply can be extended to the southern part of the district at Sutton-on-Sea if this should be required. The Alford Urban Council is, however, also prepared to supply that district, for which it has the statutory powers. At present, Sutton-on-Sea has a supply from a private company, which obtains water partly from a recently sunk bore-hole and partly in bulk from the Alford Council, and the Clerk to the latter body stated that they were prepared to enter into negotiations with the neighbouring authority for the development of their undertaking, and that by sinking a deeper bore on their land to the west of Alford, they would be in a position to offer one of the finest water supplies in Lincolnshire.

Cutlery and Plate.

There is no improvement to report in the cutlery and plate trades. They are suffering from considerable depression, to which the progress of the summer season has so far brought little or no relief. Orders from shopkeepers at home consist mainly of oddments, and the only substantial contracts coming to hand are from the catering trade. There has been a falling off this year in the demands of the shipping companies, while the cheap bazaar and coupon trades are also below the average. Good reports continue to be received from distributing houses, which are developing the system of selling cutlery on hire purchase. The great decline in Colonial purchases is a principal factor in bringing about the present state of the trade. Australia is taking small supplies of cutlery, spoons and forks, but the importation of plated or silver hollow-ware vessels is still prohibited.

NORTH OF ENGLAND.

(From our own Correspondent.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade continues to taper off in a most disappointing manner, and it has to be confessed that at the moment the prospects are quite gloomy. Very little iron is going outside the immediate area, and the requirements of the foundries in this district are much reduced. Moreover, the expectation of lower prices still persists, and purchases are limited up to the end of May. The Cleveland ironmasters still refuse to reduce their minimum prices, in spite of the loss of the whole of the export trade, and the invasion of the home market by cheaper foreign pig iron. Ironmasters cannot tempt many Scottish buyers to use Cleveland iron, although they quote lower rates than are asked in this district, and some of the local consumers are now using foreign iron. For home purposes No. 1 Cleveland foundry iron is 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade shows no improvement. Prices still incline to sag, but for small parcels of mixed numbers 65s. is quoted, with No. 1 quality at a premium of 6d. per ton. Lower terms, however, are accepted for larger quantities, and by underselling a few orders have been attracted from the Sheffield area. As foreshadowed in a previous letter, the Ayresome Ironworks of Gjers, Mills and Co., Ltd., at Middlesbrough, will be restarted next week. Two blast-furnaces are to be put into operation on the production of hematite iron, and about 400 of the firm's staff will be found employment. The works have been closed down, owing to the trade depression, for about ten months.

Iron-making Materials.

The demand for foreign ore shows no signs of expansion. Consumers have large stocks, and substantial deliveries to take under running contracts. The quotation for best Rubio ore has been cut to 15s. 6d. c.i.f. Tees, but even that low price does not attract business. Sellers of blast-furnace coke are reluctant to lower quotations, but ironmasters are buying sparingly, and confidently look forward to a downward movement. Good average qualities are offered freely at 16s. for early delivery to works in this area.

Manufactured Iron and Steel.

The position in the manufactured iron and steel trade is not encouraging. Orders are being worked off more rapidly than new ones are coming to hand, and the outlook is distinctly disappointing. Some manufacturers have great difficulty in keeping their plants in operation at even the present limited capacity, and have to rely on day-to-day orders. In the heavy steel trade producers of railway requisites have still a little work to complete, but departments engaged on manufacture of shipbuilding material are extremely slack. Conditions in the sheet branches leave much to be desired. Prices are unaltered.

The Coal Trade.

The Northern coal trade is passing through another very quiet period, and the prospects are anything but bright. In almost every grade the depression is pronounced, and shows no sign of lifting for some weeks. The fixed prices in this area are much higher than continental competitors ask. Consequently, the majority of the orders go to the Continent. German demands are lifeless, and Scandinavia is taking considerably less than merchants anticipated for the spring trade. The Northumberland steam coal position is quiet, and although quotations are made on the basis of schedule values, merchants book slowly. For prompt positions colliery owners report fairly good orders, but for the end of the month the position is disappointing. Prices are 13s. 6d. for large and 7s. 6d. for small. The reduction on the price of smalls has not yet proved attractive to continental consumers, and bookings are still of meagre volume. Ample supplies of Durham gas coal are now available, and trade is badly needed to prevent further idle time at the pits. Best qualities are obtainable at 14s. 6d., seconds at 13s. 6d., and the Wear special grade at 15s. With many vessels now preparing to proceed to the White Sea in ballast, the demands for bunker coal show some increase, but as stocks are plentiful, owners have no difficulty in covering at the recent price of 13s. 9d. to 14s. for best and 13s. 6d. for ordinary. The production of patent oven coke is still in excess of requirements, and demands make no impression on the accumulated stocks. Holders offer freely at 15s. for early clearance, Beehive and superior foundry coke is nominal at from 19s. to 24s. Gas coke stocks are not large, but demand remains slow, and prices are easy at 19s. to 19s. 6d.

Big Power Station Project.

Newcastle Electric Supply Company, Ltd., has placed a further order with Sir Robert McAlpine and Sons, Ltd., of Newcastle, in connection with its Dunston "B" power station. The order, which is valued at approximately £49,000, is for the supply, laying, jointing, and testing of the 64in. diameter inlet circulating water pipe mains required between the pump-house and turbine-house at the new station, along with a 76in. diameter outlet main from the turbine-house to the river.

SCOTLAND.

(From our own Correspondent.)

Dull Markets.

QUIETNESS prevails throughout the iron, steel, and coal markets, and there is no sign of any early change for the better. On occasion some slight activity has been recorded, but such movements have been of short duration and have hardly disturbed the prevailing depression. The consuming industries, especially shipbuilding, are very poorly placed, and buying power has been reduced to a minimum. This, together with a greatly reduced foreign inquiry, makes the outlook just as dreary as it has been for some time back.

Steel.

The lack of demand for heavy steel is reflected in the low state of production. Home requirements are extremely small and though export inquiries have been moderately good, the volume of actual business resulting has been most disappointing. The outlet for shipbuilding materials is very limited, and all classes of plates and sections are languishing. Heavy sheets receive little attention, and if light descriptions are busier, the total volume of business is not important. More inquiries are in circulation from the Far East, but firm orders are not plentiful. Galvanised sheets are extremely slow. The tube trade is passing through a very lean period, conditions at present being, if anything, worse than at any time during the past two years, and there is little likelihood of an early improvement.

Iron.

The volume of business passing in bar iron and re-rolled steel bars shows no sign of appreciating, the turnover in general being far below normal. Usual consumers of bar iron are not able to take a tenth of their usual quantities, and in many instances utilise steel owing to cheaper costs. Re-rolled steel bars make little headway against competition from English and continental producers, despite a reduction of prices to £6 10s. home and £6 7s. 6d. per ton export.

Pig Iron.

The amount of business passing in the pig iron market is not sufficient to dispose of the output of the seven furnaces in operation, owing to the continued arrivals of competitive material. Shipments from Glasgow last week amounted to 511 tons (469 tons foreign) compared with 499 tons (395 tons foreign) in the same week last year. Over 500 tons arrived at the Cylde last week.

Scrap.

Scrap materials are again cheaper at £2 10s. per ton for cast iron machinery and 41s. 3d. per ton heavy steel.

Coal.

Lack of demand at home and abroad is hampering the Scottish collieries to a considerable extent. Not only are sidings congested with loaded wagons, but in many instances large quantities of fuel are on the ground. All fuels, apart from navigations and Lanarkshire splints, are freely offered at easier prices, but buyers are apparently confident that lower rates will soon be available and are evidently content to await developments. Similarly, the prices offered are an inducement to foreign customers to purchase ahead, and any business doing is for small prompt lots. Aggregate shipments amounted to 209,159 tons, against 205,539 tons in the preceding week, and 254,043 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THE best that can be said regarding the current conditions prevailing in the steam coal export trade is that they are no worse, though it is not possible to feel altogether comfortable about the outlook. Naturally, there is considerable speculation as to what will be the result of the discussions which are now proceeding between the miners' leaders and the Government concerning their proposed Minimum Wage Bill. Another point of importance is whether working hours in the coalfield from the beginning of July are to be reduced to 7 per day, or allowed to remain as they are at present. Business is difficult enough as things are, and any addition to the costs of production will certainly prejudice the chances of successfully meeting the competition of foreign coals. Some time ago it was mentioned that steps were being taken by continental countries to foster the consumption of native coals, and judging by the demand from France their efforts to limit the imports of coal from this country are effective. Shipments are declining, and inquiries for fresh supplies are on a reduced scale. The political troubles in Spain are not helpful to business, though the Spanish Marine is in the market for a couple of cargoes for Carthagena and Cadiz. Efforts are being made to stimulate trade between this district and Brazil, but news comes to hand that the Brazil Government authorities contemplate measures which are not calculated to help the export of coal to that country. Their desire is to assist native produced coal, and to this end they propose that from July 1st imported coal may be used provided that 10 per cent. of national coal is mixed with it. This, of course, will not assist the trade which is done in coals sent from this district for the purpose of bunkering vessels at Brazilian ports. The alternative to acceptance of this proposal by importers is that the tax which is already levied upon imported coals, namely, about 8s. per ton, will be increased by 30 per cent. It is further proposed that coal-burning locomotives imported by private or public enterprises must be adaptable to the use of native coals. As things are, the demand for coals for South American destinations is much below the average, largely as a consequence of the unstable financial conditions prevailing abroad, and any additional measures of a restrictive character do not augur well for the future. Shipments from this district last week, viz., steam and anthracite coals combined, were fairly good, though a shade below the total for the preceding week. The quantity, according to the G.W.R. Company's returns, was 462,600 tons, compared with 465,300 tons, while, for the corresponding period of last year, the total was 492,290 tons. Notwithstanding the proximity of the Whitsuntide holidays, there is no real pressure at the docks. For one thing, tonnage is not so freely offered for employment, except in the short trades. At the end of last week the number of idle tipping appliances was 31, and only two steamers were waiting to berth, while, as the result of week-end arrivals, the situation on Monday was that the number of idle tips was reduced to 23 and there were six steamers waiting. So far as the inquiry for coals is concerned, the only outstanding business is that for the Egyptian State Railways, which have called for tenders to be opened on June 2nd for 100,000 or 200,000 metric tons on f.o.b. or c.i.f. conditions, the coals to be delivered at Alexandria from July to October.

Merthyr's Proposed New Works.

A movement is on foot for the establishment of new works at Cyfarthfa for the manufacture of weldless steel tubes, and the scheme was submitted to a meeting of Merthyr townspeople at the end of last week. The site for the proposed works is described as eminently suitable, and the suggested plant will give employment for about 1500 men to begin with. Every effort is being put forth to make the works a proper town's affair, and to assist the raising of the necessary capital, viz., £50,000, the workpeople are being encouraged to become co-partners in the undertaking by taking up £1 shares on the instalment system of paying so much weekly or monthly. One of the leading business firms in Merthyr has already undertaken to invest £1000 in the new works, provided nine other firms purchase equal holdings, while the owners of the proposed site for the works are agreeable to let the ground rent-free for the first five years.

Movement of Works.

Stress of competition and the need for the exercise of the utmost economy is steadily compelling leaders of industry to concentrate their activities so as to be able to produce on the best terms. Mr. L. D. Whitehead, the managing director of the Whitehead Iron and Steel Company, Ltd., states that the company has decided to concentrate on a rather lessened output in its more modern plant at Newport and to close down at Tredegar until there is an improvement in trade conditions. This decision will take effect in about a fortnight's time, and will mean that about 250 men will be concerned, though it is hoped that about 100 of them will be transferred to Newport. A new mill constructed by the firm came into operation on Monday last. Work on its construction was begun last year. It is a Morgan semi-continuous bar and strip mill of entirely new design, and is probably the biggest unit of its type in the world. The report is also current that the Post Office authorities contemplate removing the whole of the Newport engineering department to Cardiff as from October 1st. This action, if true, is sure to meet with the utmost opposition from Newport business people.

Employment Schemes.

The Cardiff Corporation decided on Monday to proceed forthwith with the construction of its orbital road scheme, calculated to cost £200,000, to which the Government will contribute 75 per cent. The scheme has met with a good deal of opposition on the ground that it is not required and will take away business from the centre of the city. Subject to certain conditions, the Newport Town Council has decided to proceed with the construction of the Talybont reservoir. It is understood that, subject to the formal approval of the Government being received, it will be possible to let the contract in about three weeks' time, and in that event it will probably mean that 100 men will be at work before the end of July. The whole scheme will eventually employ some 400 or 500 men for a period of about five years and the cost will run to about £430,000.

Spelter Works.

The price of spelter is now lower than it has ever been, viz., about £10 10s. per ton, and the result is that another two of the ten distillation furnaces at the Swansea Vale Spelter Works, Llansamlet, are to go out of commission at the end of this week. Four furnaces were stopped some time ago and this further curtailment of operations will mean that every department of the works will be on short time.

Current Business.

The general tone of the steam coal market is quiet, and there are very few fresh inquiries for supplies for early shipment. Most qualities of large coals are fairly well stemmed, but smalls are extremely excessive, while sized coals do not meet with a very active demand. Coke and patent fuel show no material development and there is no improvement in pitwood. Consideration by sub-committees of the South Wales Coalowners and the Merchants' Federation is being given to the question of the marketing of house coal with a view to securing greater co-ordination between coalowners, factors and merchants. The proposals provide that only members of the Merchants' Federation shall be supplied with coal by the collieries and factors and that margins should be established in respect of the price charged to consumers by the retailers for the different quality coals.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

SPENCER-BONECOURT, Ltd., have removed their offices to 32–33, Farringdon-street, London, E.C. 4. Their telephone numbers will be Central 4201–2.

THE League of Nations has convened a European Conference on Rural Hygiene and Sanitation at Geneva on June 29th, 1931. The British Government is sending a delegation of three representatives, one of whom is a civil engineer, Mr. H. Ross Hooper, of the firm of Parker Pearson and Ross Hooper, chartered civil engineers, of Chippenham.

CRAVEN BROTHERS (MANCHESTER), Ltd., of Vauxhall Works, Reddish, Stockport, inform us that they have disposed of their interests in the electrical and steam breakdown crane business to Herbert Morris, Ltd., Loughborough, *i.e.*, goodwill, patents, patterns and designs. Herbert Morris, Ltd., will continue to manufacture the specialised line of "Craven" cranes under the title of Herbert Morris, Ltd. (Craven Brothers Crane Division).

THE MORGAN CRUCIBLE COMPANY, Ltd., London, announces that arrangements have been made whereby the sale of the Morganite system of radiant heating and that of the Electrorad low-temperature panel system, will be handled by the patentees of the latter. Similarly, the Morganite radiation and thermostat and control apparatus will now be available for use with both systems. The two systems will retain their separate identities, and the Morganite element will continue to be used. Complete continuity has been ensured by an exchange of staff, and all communications should be addressed to Electro-Gas Development Company, Ltd., 3, Arundel-street, London, W.C. 2.

CONTRACTS.

SIR WILLIAM ARROL AND CO., Ltd., of Glasgow, and London, have received an order from the Roan Antelope Copper Mines, Ltd., for one 15-ton overhead travelling crane.

G. D. PETERS AND CO., OF CANADA, Ltd., have received orders from the Canadian Pacific Railway Company for the supply of miscellaneous stores, chiefly Wilson plastic arc welding material.

THE GENERAL ELECTRIC COMPANY, Ltd., has received an order from the Sunderland Corporation Tramway and Motor Department for twenty-four self-ventilated tramway motors, type W.T. 28 K.S., each rating at 50 H.P., 500 volts, on the one-hour rating.

J. AND E. HALL, Ltd., of Dartford, Kent, have just supplied the plant for "quick freezing" to the vessel "Karsvik," which is owned by A/S Kveitefiske, of Oslo. The vessel has left for the Greenland halibut fishing grounds and has storage capacity for about 500 tons.

INTERNATIONAL CONFERENCE ON LARGE ELECTRIC HIGH-TENSION SYSTEMS.—The sixth session of the International Conference on Large Electric High-tension Systems will be held in Paris from Thursday, June 18th, to Saturday, the 27th. Since the Conference was created in 1921 under the auspices of the International Electrotechnical Commission, sessions have been held every other year regularly. Therefore the next session will be the sixth, and it will give an opportunity for the celebration of the tenth anniversary of the creation of the Conference. We are informed that 525 engineers, representing twenty-one countries, are already registered for the forthcoming session, and it seems likely that the number of delegates will be higher than in 1929, when it was 703. One hundred papers will be presented and debated; they will be grouped in three different two-day sections. For registration application should be made to Mr. Tribot Laspière, Director and Secretary of the International Conference on Large Electric High-tension Systems, Avenue Marceau 54, Paris (formerly Boulevard Malesherbes, 25).

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/- to 20/6
(1) Spanish	16/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	15/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 12 0	—
No. 1 Foundry	3 16 0	—
No. 3 Foundry	3 13 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 5 0	3 5 0
No. 1	3 5 6	3 5 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(e) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 6 0	—
„ „ Foundry	3 11 0	—
(e) Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
(e) Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 1 6 (a) / 4 3 6 (b) / 4 8 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
Lancs.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 10 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 9 0 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 10 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 5 0	8 0 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 2 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	8 12 6 and 9 2 6	—
Intermediate Basic	7 2 6 and 7 12 6	—
Soft Basic	6 5 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 15 0	—
Midlands—		
Small Rolled Bars	6 17 6 to 7 5 0	—
Billets and Sheet Bars	5 5 0 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	11 0 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 0 0	—

NON-FERROUS METALS.

Swansea—		
Tin-plates, I.C., 20 by 14	f.o.b.	14/9 to 15/-
Block Tin (cash)		104 5 0
„ (three months)		105 12 6
Copper (cash)		39 15 0
„ (three months)		40 10 0
Spanish Lead (cash)		11 11 3
„ „ (three months)		11 17 6
Spelter (cash)		—
„ (three months)		—
Manchester—		
Copper, Best Selected Ingots		43 0 0
„ Electrolytic		43 10 0
„ Strong Sheets		73 0 0
„ Tubes (Basis Price), lb.		0 0 10¾
Brass Tubes (Basis Price), lb.		0 0 9½
„ Condenser, lb.		0 0 11¾
Lead, English		12 17 6
„ Foreign		11 15 0
Spelter		11 0 0
Aluminium (per ton—raw ingot)	£85	

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11½ per lb.	
Ferro Tungsten	1/8½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£20 10 0	7/-
„ „ 6 p.c. to 8 p.c.	£19 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£19 0 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£31 0 0	10/-
„ „ „ 1 p.c. carbon	£34 0 0	12/-
„ „ „ 0·70 p.c. carbon	£36 0 0	14/-
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 0 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	9/- per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	14/9
„ „ Splint	14/9 to 16/6
„ „ Trebles	12/-
„ „ Doubles	10/6
„ „ Singles	9/-
Ayrshire—	
(f.o.b. Ports)—Steam	13/-
„ „ Jewel	17/-
„ „ Trebles	12/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	11/6 to 12/3
Screened Navigation	16/6 to 17/6
Trebles	11/6 to 12/6
Doubles	10/6 to 11/-
Singles	9/-
Lothians—	
(f.o.b. Leith)—Best Steam	12/-
Secondary Steam	11/6
Trebles	12/- to 12/6
Doubles	11/- to 11/3
Singles	9/-

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	20/-
Household	30/- to 51/-
Coke	20/- to 20/6
Northumberland—	
Best Steams	13/6
Second Steams	12/-
Steam Smalls	7/6 to 8/-
Unscreened	12/6 to 13/-
Household	27/- to 39/-
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	24/-
Sheffield—	Inland.
Best Hand-picked Branch	25/6 to 27/-
Derbyshire Best Bright House	24/- to 26/-
Best House Coal	22/- to 23/-
Screened House Coal	19/6 to 20/6
„ „ Nuts	16/6 to 17/6
Yorkshire Hards	15/- to 16/6
Derbyshire Hards	15/- to 16/6
Rough Slacks	9/- to 10/-
Nutty Slacks	7/- to 8/-
Smalls	4/6 to 6/6
Blast-furnace Coke (Inland)	12/3 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b. 15/- to 16/-	

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	20/- to 20/3
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/6
Ordinary Dry Large	17/9 to 18/-
Best Black Vein Large	18/6 to 18/9
Western Valley Large	18/- to 18/6
Best Eastern Valley Large	18/- to 18/3
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/- to 13/6
Washed Nuts	18/- to 22/-
No. 3 Rhondda Large	19/9 to 20/3
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/- to 26/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	20/6 to 21/-
Pitwood (ex ship)	23/6 to 23/9
Swansea—	
Anthracite Coals:	
Best Big Vein Large	35/- to 37/6
Seconds	27/- to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/-
Nuts	43/- to 46/-
Beans	24/9 to 28/3
Peas	20/- to 21/6
Breaker Duff	8/6 to 9/-
Rubbly Culm	8/6 to 9/6
Steam Coals:	
Large	20/6 to 21/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Trade.

A MONTH ago there was some satisfaction in believing that prices of iron and steel on the international market had touched bottom and that they could go no further. It is now seen that the bottom has not been reached, for in Brussels prices are down a further 2s. 6d. a ton, bars being now £3 14s. A disturbing factor is the increasing competition from Germany for foreign trade, particularly in the Far East, for which German mill and forge owners are quoting bars at £3 12s. 6d. per ton f.o.b. Antwerp. Meanwhile, production is declining all round. With a steel output of 2,161,000 tons during the first quarter of the year, France is still the only country, besides the Saar, to exceed the quota provided by the Steel Cartel, the surplus being 181,000 tons, while the German production falls short of the quota by 543,000 tons. The Committee of the Steel Cartel is to hold another meeting in Paris shortly and again in Budapest, in the hope of reaching a settlement which will justify an extension or renewal of the Cartel at the end of June. In view of the seriousness of the situation, the only organisation that links steel producers in different countries together must not be broken, and it is believed that the main difficulties are being overcome whereby an acceptable arrangement may be reached for the preservation of the Cartel.

The Railway Crisis.

While the Conseil Supérieur des Chemins de Fer is preparing a plan to save the railway companies from financial disaster without the necessity, if possible, of increasing still further the railway rates, the various bodies representing all classes of users fear apparently that higher rates are inevitable, unless public opinion is aroused against them. They have all published reports at the same time, each with its own particular line of argument. The Confédération Générale de la Production Française, which is by far the largest and most influential body, deals with the causes of the deficit, which amounted to 2000 million francs in 1930 and is now increasing at the rate of 280 million francs a month. The causes are attributed entirely to the railways being under the jurisdiction of the State, and consequently at the mercy of political and other influences in Parliament. The carrying of mails costs the railway companies 600 million francs a year, and the military transports are a heavy burden upon them, while the suburban services are arranged in obedience to parliamentary exactions, and are in all cases run at a heavy loss. The eight hours' working day was enforced under conditions that entailed an extra charge on the companies of 1700 million francs a year. At country stations men are paid for doing practically nothing. The State railways initiated higher wages and social reforms of all kinds, and they are responsible for two-thirds of the total deficit of all the railways. The companies were helpless in face of this extravagance until, in desperation, they issued their manifesto declaring that they refused to depart any longer from the Convention of 1921. The Confédération Générale de la Production Française now proposes remedies which consist in the suppression of all State interference and the obligation of the Post Office, military, and other State administrations to pay their own transport charges, instead of putting them on the backs of the railway companies. In a word, the railways must be taken out of the administrative rut and run like other industrial undertakings under the sole management of the companies, which will have full initiative to adapt them to modern conditions of traffic in association with road, air, and inland waterway transport. Other associations also insist upon the necessity of the railway companies being allowed to take full advantage of modern transport facilities. These efforts to enlighten the public upon the real state of affairs are obviously intended to bring pressure upon Parliament to remove all State interference in the working of the railways, and to allow the companies to manage them in a rational and economical manner.

Naval Construction.

In presenting the list of ships to be laid down during 1931 and 1932 under the Naval Programme, Monsieur Charles Dumont, the Minister of Marine, affirms that the tonnage does not exceed that fixed by the pact now under consideration by France, Great Britain, and Italy. As a matter of courtesy, particulars have been forwarded to the Governments of the two latter countries. A noteworthy feature is a battleship of 23,333 tons, the first of three to come within the total of 70,000 tons allotted to France by the London Agreement until the end of 1936. The construction of this ship was decided upon in reply to the German 10,000-ton "pocket battleships," and it is reported that the French naval architects have evolved a type of battleship which combines successfully speed with powerful armament and protection. There will also be two second-class cruisers, a sloop for colonial service, and various other craft that do not come within the limitation agreement. No submarines are included in the coming instalment of naval construction.

Port of Havre.

While Havre is the leading Transatlantic port, it lacks convenience for the transference of passengers from ship to train, and in the programme of works being carried out to provide Havre with a modern equipment is included the reconstruction of the existing harbour and town stations, with an extension eventually of the railway to the harbour. Last week the work on the two stations was officially begun, when a special train, composed of the new Transatlantic coaches, was run from Paris to Havre. The steel coaches are of the Pullman type, and are the first of their kind to be run in France. The harbour station will have a length of 600 m. and a width of 45 m., so that it will be able to provide for landing simultaneously from two Transatlantic steamers. It will be the largest and best equipped in the country.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

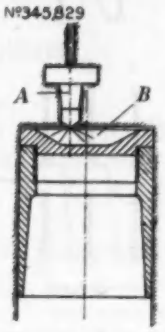
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

345,829. April 9th, 1930.—SOLID INJECTION ENGINES, Daimler-Benz Aktiengesellschaft, Stuttgart, Untertürkheim, Germany.

Practically all that is protected by this patent is the excentric arrangement of the pre-combustion space A, as regards the depression in the piston head B, which is claimed to promote turbulence of the mixture, and consequently its thorough combustion.—*April 2nd*, 1931.

Nº345,829

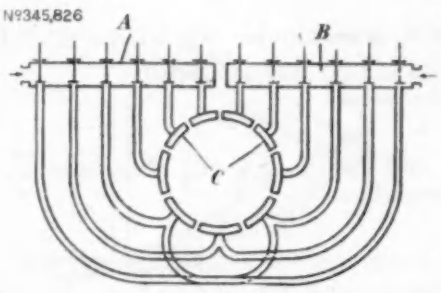


TURBINE MACHINERY.

345,826. April 3rd, 1930.—MIXED-PRESSURE STEAM TURBINES, *International General Electric Company, Inc., 120, Broadway, New York, U.S.A.*

This invention is concerned with steam turbines which are connected with two separate supplies of steam, such as those coming direct from a boiler plant and another from an accumulator. These two supplies are connected with the headers A and B, which supply the nozzle units C C of the turbine.

Nº345,826

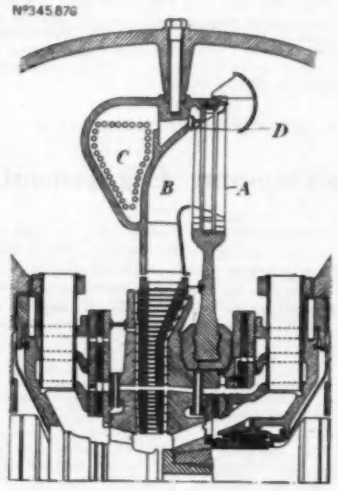


It will be noticed that the first three units of nozzles connected with either of the headers are independent, and that there are three other units, which are interconnected. The governing arrangement is such that the primary units are put into service in rotation according to the load on the machine, while the secondary units may be brought in when necessary. The specification gives no hint as to the means of regulating the flow to the various units of nozzles.—*April 2nd*, 1931.

345,876. May 17th, 1930.—RADIAL-FLOW STEAM TURBINES, Aktiebolaget Ljungströms Angturbin, Västra, Trädgardsgatan 17, Stockholm, Sweden.

This invention is virtually a development of the principle of bleeding steam off from a turbine for heating feed water. The turbine, it will be seen, is of the Ljungström type, with a radial flow through the high-pressure stages, and an axial flow through

Nº345,876



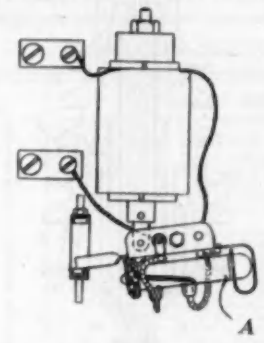
the low-pressure blading A. The low-pressure steam is guided entirely to one side by the duct B, on the bend of which there is arranged the feed-water heater C. This heater is supplied with steam by the deflector D. It is claimed that the arrangement has the merit of bringing the heater into such a position that losses while the bled steam is passing from the turbine to the heater are reduced to a minimum.—*April 2nd*, 1931.

SWITCHGEAR.

345,757. February 10th, 1930.—ELECTRO-MAGNETICALLY OPERATED MERCURY SWITCHES, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and John James Vincent Connaughton, of the General Electric Company, Ltd., Union Works, Wembley, Middlesex.

This invention relates to electrical switches, relays, &c., its object being to provide a simple relay which is cheap to manufacture and is reliable in operation. In accordance with the invention, the core of a solenoid is connected to a mercury switch A, and when current is applied to the solenoid the core rises, whilst when the current is cut off the core falls under the action of gravity. The device may be arranged to act as a continuously operating interrupter for controlling a flashing

Nº345,757

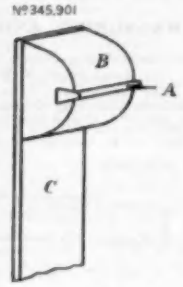


sign, for instance, by passing the operating current for the solenoid through the mercury switch. Each time the solenoid is energised and lifts its core the circuit is broken, thus causing the de-energisation of the solenoid, the return of the core under gravity, and the re-closing of the circuit through the mercury switch.—*April 2nd*, 1931.

345,901. June 27th, 1930.—CONTACTS FOR ELECTRIC SWITCHES, *International General Electric Company, Inc., of 120, Broadway, New York, United States of America.*

Copper switch contacts have the disadvantage that, in the event of the switch arcing, a layer of copper oxide forms which has a high resistance and thus impairs the conductivity of the contact. The rare metals, such as silver, tungsten, &c., which do not possess this disadvantage, cannot be employed on account of their high price. According to the invention, one or more strips of silver or similar metal are secured by wedging or dovetailing to a block of a cheaper conductive material sufficiently large for conducting off the heat, the outer end of each strip projecting beyond the block. In the example of the invention shown, a strip of silver A is let into a copper contact B, which is attached to a resilient support or finger C. The silver strip makes the contact, whilst the copper block serves for conducting off the heat.—*April 2nd*, 1931.

Nº345,901

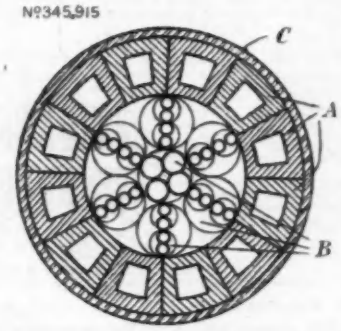


TELEGRAPHS AND TELEPHONES.

345,915. August 5th, 1930.—ELECTRIC CABLES, Kabelfabrik und Drahtindustrie Actien-Gesellschaft, of Oswaldgasse 33, Vienna XII., Austria.

This specification describes an electric cable in which the cable core is protected against external pressures by a pressure protection formed of wires. Such a pressure protection is essential for submarine cables, as they have to be laid at great depths and must be capable of withstanding the water pressure. It is important, however, that the pressure protection shall not greatly increase the weight of the cable. According to the invention a pressure protection for electric cables is obtained by using hollow-metal wires, which are laid over the core of the cable.

Nº345,915



The laid hollow wires A have a trapezoidal cross section, and abut against one another in such a manner that an arch-like hollow rope is formed, which is capable of withstanding very high pressures. In the interior of the cable a core B is embedded, and is thus protected against the external pressures. In order completely to seal the cable and prevent the penetration of water and moisture into the cable, a sheath C of a dense material which is impervious and stable as regards water can be placed over the pressure protection—for instance, a lead sheath or a sheath of gutta-percha or rubber. To secure the hollow section wires in the cable in position with respect to one another and to prevent the wires springing out of the rope, the wires A are keyed to one another in any suitable way.—*April 2nd*, 1931.

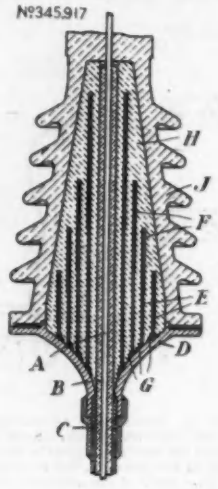
TRANSMISSION OF POWER.

345,917. August 15th, 1930.—ELECTRIC CABLE END SLEEVES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemenastadt, Germany.

It has been found that in electric cable end sleeves the risk of arcing across is substantially greater than the risk of puncturing. In order to augment the power of resisting arcing across it has been proposed to embed in the impregnated paper used for the insulation either conductive or semi-conductive insertions, but the manufacture of the end sleeves in accordance with the usual method necessitates a considerable amount of time, owing to the necessity of winding. A cable end sleeve made in accordance with the invention is shown. A is the conductor of the cable, B the paper insulation mounted upon the conductor, and C the lead jacket of the cable. The lead jacket is removed from the end of the cable to the requisite length. Upon the end of the lead jacket a funnel D is mounted, and serves as a supporting member for the insulator of the end sleeve. Around the insulating tube B of the cable there are cylinders E, which serve as supports for the conductive or semi-conductive

layers F. In order that these layers may be insulated in relation to each other and to the earth they must not extend right up to the metal funnel. The cylinders E are made of pressed paper or millboard. In order to prevent any displacement of the

No345,917



cylinders in the end sleeve, lugs G of insulating material are provided. After placing the end sleeve in position upon the cable jacket the sleeve is filled with a liquid or viscous insulating substance H. J is the insulator closing off the end sleeve.—*April 2nd*, 1931.

MEASURING AND TESTING INSTRUMENTS.

345,456. February 28th, 1930.—SPIRIT LEVELS, F. Smallwood, 96, Leopold-street, Birmingham.

This spirit level is intended to overcome the drawbacks of levels with long bubble tubes caused by expansion and contraction. It is equipped with two, or more, short tubes arranged

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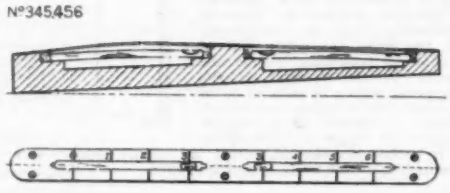


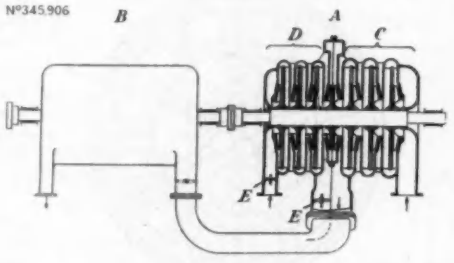
in line and bent to a common curvature. The divisions on the scale are so arranged that when the bubble in the first tube arrives at the extremity, the bubble in the second tube starts from a corresponding mark, and so on, with any further tubes.—*March 26th*, 1931.

PUMPING AND BLOWING MACHINERY.

345,906. July 11th, 1930.—CENTRIFUGAL AIR COMPRESSORS, Siemens-Schuckertwerke Aktiengesellschaft, Berlin-Siemensstadt, Germany.

This arrangement of centrifugal blowers, or compressors, aims at the minimising of the "pumping," or surging, of compressors when the volume output is reduced below the condition of stability. The machine is in two parts, a low-pressure section

No345,906



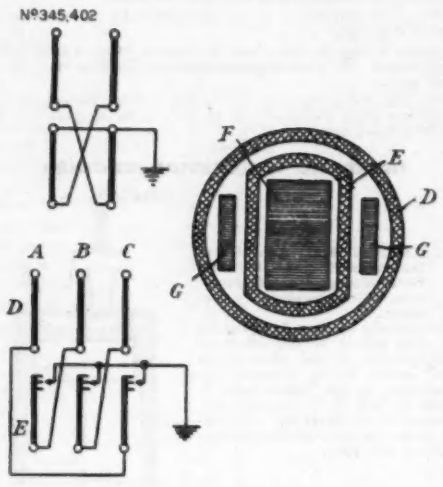
A and a high-pressure section B. The low-pressure section is divided into two parts C and D, one of which can be put out of action by means of the dampers E E. The two half-sections, it will be noticed, are of different capacities, but the reason is not fully disclosed. It is suggested that the inactive part of the low-pressure blower may be evacuated to reduce windage losses.—*April 2nd*, 1931.

MISCELLANEOUS.

345,402. January 23rd, 1930.—MEANS FOR SUPPRESSING THE EARTHING CURRENT IN ELECTRIC DISTRIBUTION SYSTEMS, *International General Electric Company, Inc., of 120, Broadway, New York.*

Various arrangements of reactance coils have been proposed for suppressing the earthing current in electric distribution systems. It has been proposed, for example, to insert reactance coils between each line of the systems and earth, the coils being subdivided and arranged on the limbs of the core with the parts of each coil mounted on different limbs. Such an arrangement of coils may be connected with advantage in zigzag fashion. It is desirable that the magnitude of the compensating current should be suited to the resultant capacity current to earth, *i.e.*, according to the length of conductor in operation. The invention provides an earthing reactor of the type above described, in which the winding parts arranged on each limb have different numbers of turns, the difference of the ampère-turns being such as to produce the flux necessary for obtaining the desired current. The number of turns of one or both parts of each winding may, in addition, be regulated by tappings. It is immaterial whether the tappings are placed near the zero point or at any other point of the winding. One arrangement of reactor designed in accordance with this invention is shown. The windings of the three phases A B C are subdivided and zigzag connected. The winding parts D and E arranged on each limb are of different magnitudes, and the number of turns of the part E can be regulated by tappings. By this means the desired current can be adjusted with the necessary accuracy. The magnitude of the stray flux can be adjusted by variable air gaps on auxiliary cores or by other known means. If, by means of the auxiliary cores, only coarse adjustment of the stray flux is

No345,402



made, the fine adjustment can be obtained by means of tappings. In the right-hand drawing a limb of a reactor fitted with auxiliary cores is shown in section. D and E are the two windings arranged concentrically on the main limb F. G are the auxiliary limbs which are surrounded by the winding D.—*March 26th*, 1931.

345,015. January 25th, 1930.—DRAFTING MACHINES, G. Carwardine, 17, Macaulay Buildings, Widcombe Hill, Bath.

In this drafting machine an attempt is made to provide a cheap and efficient bearing at the intersections of the parallel linkage. The general arrangement of the device is shown in Fig. 1, while Fig. 2 gives details of the connection at the intermediate point A. The links B B B B are all channel shaped and

No345,015

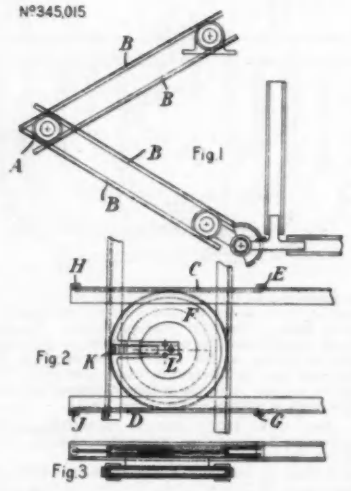


Fig.1

Fig.2

Fig.3

are held at the pivot points by wires C D. The wire C is attached to one link at E, passes half round the pulley F, and is attached to the corresponding link at G. The twin wire D is attached to one link at H, passes round the pulley in the opposite direction, and is attached to the other link at J. In order to tension the wires properly the wire C passes through a hook bolt at K, which can be tightened up by the nut L. Similar arrangements are made at the other joints.—*March 19th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. Annual general meeting. 8 p.m.

PHYSICAL SOCIETY.—At the Science Museum, South Kensington, S.W. 7. Guthrie Lecture, "Standards of Measurement, their History and Development," by Sir Richard Glazebrook, F.R.S. 5.15 p.m. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Experimental Aspects of Hydrogen-Ion Concentration," by Dr. J. C. Philip, F.R.S. 9 p.m.

SATURDAY, MAY 16TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District Meeting at Cheltenham. Assemble Town Hall at 10.30 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Wakefield. Assemble at Town Hall, 11 a.m.

TUESDAY, MAY 19TH.

BUSINESS RESEARCH AND MANAGEMENT ASSOCIATION OF GREAT BRITAIN.—Anderton's Hotel, Fleet-street, London, E.C. 4. "Budgetary Control as an Aid to Team Work," by Mr. A. P. Young. 7 p.m.

INSTITUTE OF INDUSTRIAL ADMINISTRATION.—In the Lecture Hall, Institute of Hygiene, 28, Portland-place, London, W. 1. "Higher Control," by Mr. T. G. Rose. 6.30 p.m.

INSTITUTE OF PHYSICS.—At the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. "Physics in Relation to the Development of the Internal Combustion Engine," by Mr. Alan E. L. Chorlton. 4.30 p.m.

WEDNESDAY, MAY 20TH.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—All-day visit to Synthetic Ammonia and Nitrates, Ltd., at Billingham. Leave Huddersfield at 8.30 a.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Visit to the Broughton Copper Company, Ltd., Blackfriars-road, Salford. 2.30 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, S.W. 7. Meeting at 5 p.m.

ROYAL MICROSCOPICAL SOCIETY.—Hastings Hall, B.M.A. House, Tavistock-square, London, W.C. 1. Meeting at 5.30 p.m.

THURSDAY MAY 21ST.

INSTITUTION OF MINING AND METALLURGY.—At the Rooms of the Geological Society, Burlington House, Piccadilly, London, W. 1. Annual general meeting. Presentation of awards, presidential address. "Reflections on the Relative Effect of the Fall in Metal Prices on Base Metal Mining Compared with that of Gold," by Mr. W. Pellew-Harvey. 5.30 p.m.

FRIDAY, MAY 22ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "X-ray Investigations of the Structure of Liquids," by Sir William Bragg, F.R.S. 9 p.m.

MONDAY, MAY 25TH.

ENGINEERING GOLFING SOCIETY.—Northern meeting at Gullane, No. 1 Course.

THURSDAY TO SATURDAY, MAY 28TH TO 30TH.

VEREIN DEUTSCHER CHEMIKER.—Vienna. Fifth general meeting for chemical apparatus. Symposium, "The Separation of Liquids and Solids."

SATURDAY TO SUNDAY, MAY 30TH TO JUNE 14TH.

INSTITUTE OF TRANSPORT.—Italian Tour and Congress. For provisional programme see page 359.

MONDAY TO FRIDAY, JUNE 1ST TO 5TH.

INTERNATIONAL FEDERATION FOR HOUSING AND TOWN PLANNING.—Berlin. Thirteenth International Housing and Town Planning Congress.

THURSDAY, JUNE 4TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "A New Form of Prime Mover and its Uses for Locomotives, Marine and other Engines," by Mr. J. F. J. Malone. 6 p.m.

WEDNESDAY TO SATURDAY, JUNE 17TH TO 20TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Birmingham. Fifty-eighth annual general meeting and conference. For programme see page 524.

WEDNESDAY, JUNE 24TH.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Annual excursion. Visit to the National Physical Laboratory, Teddington.

MONDAY TO SATURDAY, JUNE 29TH TO JULY 4TH.

INSTITUTION OF NAVAL ARCHITECTS.—Paris summer meeting. For programme see page 514.

MONDAY TO SATURDAY, JULY 13TH TO 18TH.

SOCIETY OF CHEMICAL INDUSTRY.—Jubilee Celebrations. For provisional programme see page 471.

THE INSTITUTION OF MINING AND METALLURGY: AWARDS.—The gold medal of the Institution of Mining and Metallurgy has been awarded to Dr. Charles Camsell, Deputy Minister of Mines and Industries of the Dominion of Canada, "in recognition of his untiring zeal and great ability in promoting the development of the natural resources of the Dominion, and in furthering the general interests of the mineral industry." The following awards have also been made:—The Consolidated Gold Fields of South Africa, Ltd., gold medal to Mr. C. W. B. Jeppe, A.R.S.M., Assoc. Inst. M.M., for his researches in mine ventilation at great depths, and for his paper on "Ventilation at the Crown Mines, Witwatersrand;" the Consolidated Gold Fields premium of forty guineas to Mr. E. G. Lawford, A.R.S.M., Assoc. Inst. M.M., for his "Notes on Some Stoping Problems in Mexico:" and the William Frecheville students' prize of ten guineas to Mr. W. H. Wilson, A.R.S.M., for his paper on "Bottom Slicing Applied to Mining a Large Irregular Replacement Deposit in Limestone."

THAMES TO TRENT WATERWAY.—Parliamentary sanction for the purchase of three more canals is sought by the Grand Union Canal Company in a Bill deposited in the House of Commons on Wednesday, May 6th. The canals, which are all at the northern end of the Grand Union system, are the Leicester Navigation, the Loughborough Navigation, and the Erewash Canal. Their acquisition will add nearly 40 miles to the 240 already under the control of the company, and eventually make possible the passage from London to the Trent of motor barges considerably larger than those now in use. A scheme for the substitution of larger locks for the seventeen narrow locks at Watford (near Daventry) and Foxton has already been prepared, and formal application has been made to the Development (Public Utility) Advisory Committee for a grant of interest on the capital outlay required, which is estimated at £150,000. The extension will give Nottinghamshire and Derbyshire firms engaged in the coal and iron industries, and Leicestershire granite merchants access to the Regent's Canal Dock, Limehouse, and the Thames at Brentford.

ENGINEERING GOLFING SOCIETY.—The spring meeting of the Engineering Golfing Society was held at Aldeburgh on Saturday and Sunday, May 9th and 10th. On the Saturday morning, in a four-ball foursomes match play against bogey, the "Timmis" cups and mementoes were won by G. H. Hopewell and P. V. Hunter, with all square; the second prizes falling to E. C. MacKellar and Walter Phillips, with 1 down. In the afternoon, in two-ball foursomes match play against bogey, the first prizes were won by J. A. Dixon and G. V. Twiss, with 2 down; and the second prizes by H. E. Midgley and R. L. Soper, with 3 down, after a tie with G. H. Hopewell and P. V. Hunter. In a stroke competition on the Sunday morning the "President's" cup and memento were won by H. E. Midgley, with 84—6=78, after a triple tie with R. B. Grey and C. Stewart. R. B. Grey, with 85—7=78, won the second prize. The "Wilson" cup and memento were won by K. W. Macnee, with 96—16=80, after a tie with G. N. Wright, who took the second prize. P. L. Riviere took the "Captain's" prize in the first division, and G. N. Wright the "Captain's" prize in the second division. In the afternoon friendly matches were played. The prizes were distributed by Dr. S. L. Pearce.